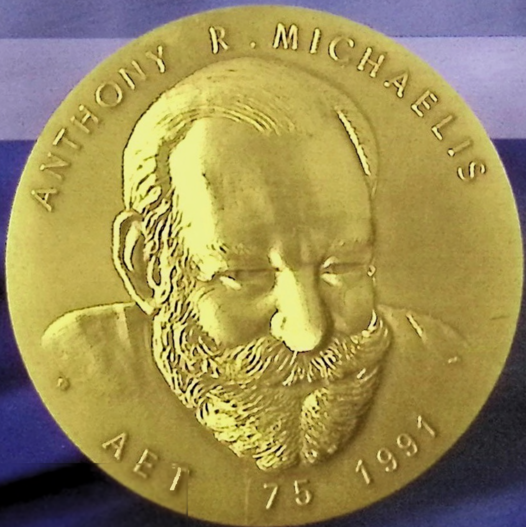
ANTHONY R. MICHAELIS

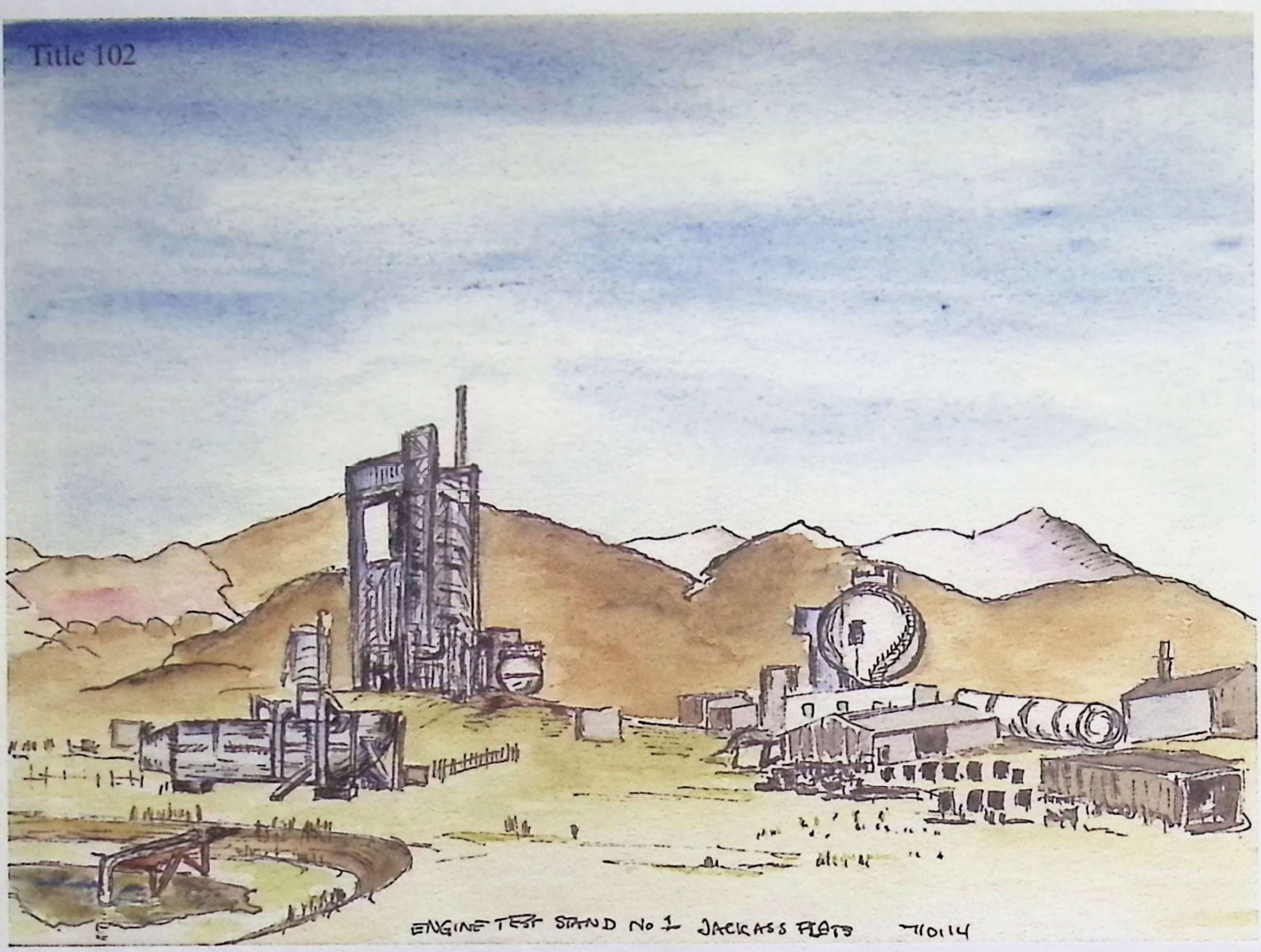
The Scientific Temper



An Anthology of Stories on Matters of Science

Universitätsverlag
C. WINTER
Heidelberg

Title 102



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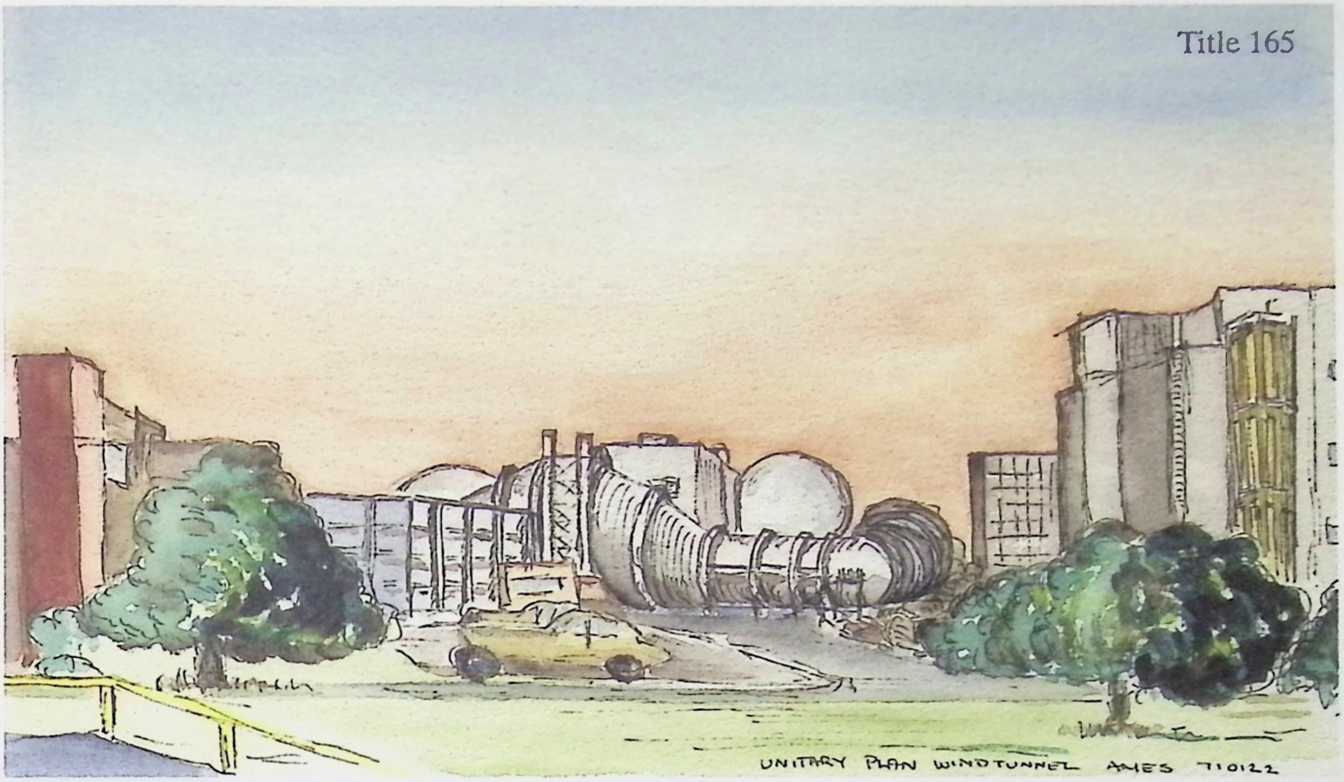


THE AUTHOR'S WATERCOLOURS

Title 102

I saw the world's most powerful atomic reactor, built to propel rockets in space, at Jack Ass Flats, Nevada, USA.

Title 149

To take me at night to a scoop at a secret rendezvous in the middle of the British Channel, I was allowed to use THV *Stella*.

Title 165

The wind tunnel at NASA's Ames Research Station where Apollo was tested.

Title 228

CENSORED – Too gruesome to publish, convict "punishment" cells in the French Penal Colony of Guyana, overgrown now with jungle roots.

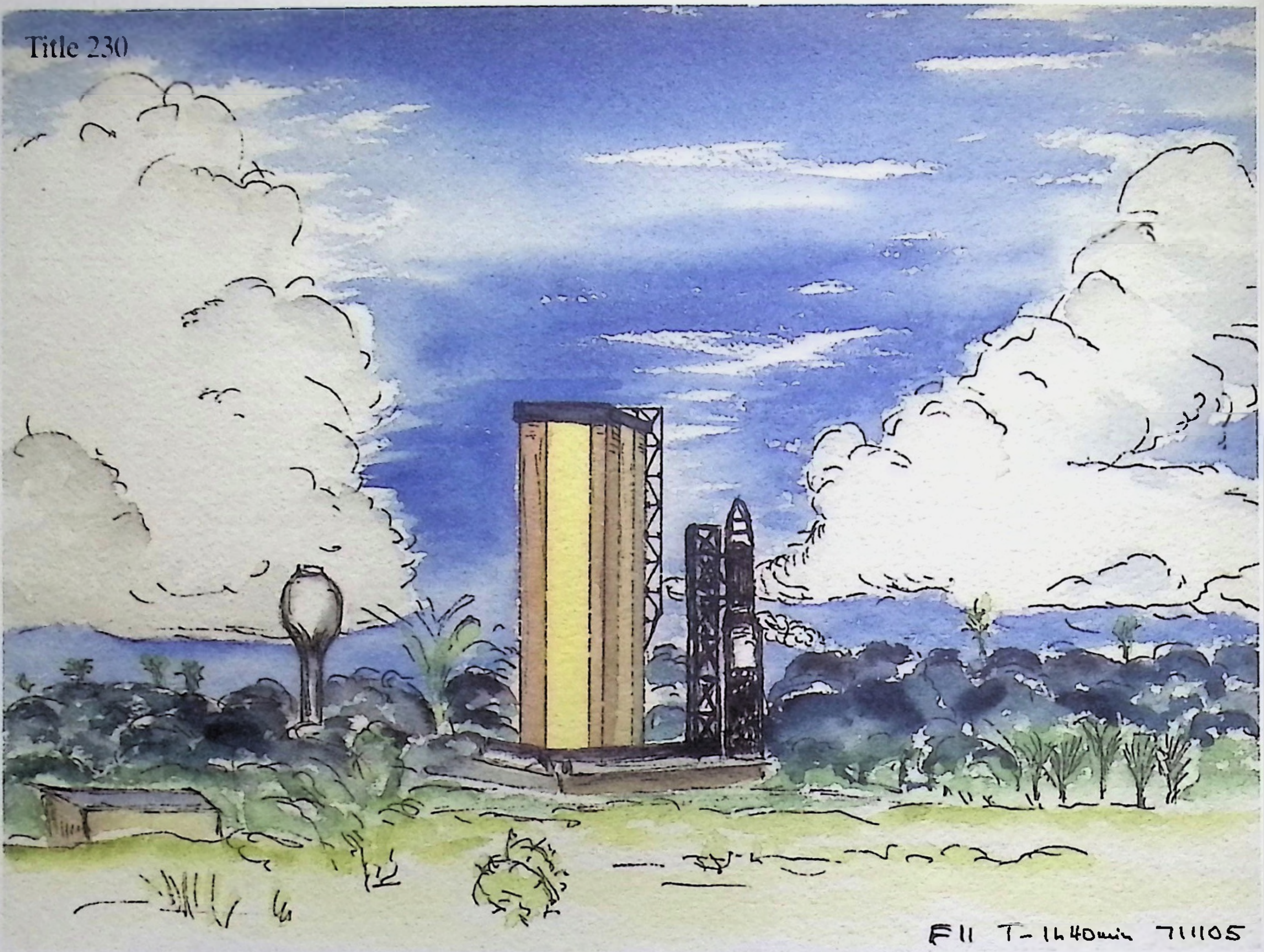
Title 230

Disastrous launch of Europa rocket F 11 – it flew only 50 seconds – at Kourou in French Guyana.

Title 232

I first thought of Chemophobia at Sodom and Gomorrah by the Dead Sea.

Title 230



Title 232

The Scientific Temper

Die Deutsche Bibliothek – CIP-Einheitsaufnahme

Michaelis, Anthony R.:
The Scientific Temper: An Anthology of Stories on Matter of Science /
Anthony R. Michaelis. – Heidelberg: Winter, 2001

ISBN 3-8253-1229-1

The watercolour illustrations are the work of the author.

For the explanations of the details of the medal
on the front and back cover, see page 528, Title 439 A

ISBN 3-8253-1229-1

Printed in Germany · Imprimé en Allemagne
Publisher: Universitätsverlag C. Winter Heidelberg GmbH
Printing: Betz-Druck GmbH, Darmstadt

Printed on acid-free paper

THE SCIENTIFIC TEMPER

Is for me the Spirit of our Time at its best.
Trying, wherever possible, to introduce Science
into the Culture of Men and Women
for their Benefit.

The Scientific Temper is not a new ethos and has guided many great scientists in the past. It was central to the philosophy of Nehru, himself a trained scientist, when he was able to introduce Science as a significant influence to solve the many problems of India. To him, the application of reason to human affairs and a disinterested search for truth, were the criteria which guided his life, but he did not succeed in overcoming all of India's conservative and popular beliefs [See Title 341]. I first came across the phrase 'Scientific Temper' in the article by Professor S. Gopal "Nehru and Science" in *Interdisciplinary Science Reviews* Vol 10/2, p. 105 (1985) where Gopal discussed Nehru, after he became India's first Prime Minister in 1947. It also occurs often in *Jawaharlal Nehru on Science and Society, A Collection of his Writings and Speeches*, edited by Balder Singh, Nehru Memorial Museum and Library, New Delhi 1988.

The short, interdisciplinary scientific stories in this book reflect a few examples of my own scientific temper as an influence on human affairs and culture, which I was able to find, report and publish.

A.R.M. 1.1.2000
The Augustinum
Heidelberg

THE SCIENTIFIC TEMPER

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[illegible]

[illegible] scientific temper [illegible]

[illegible] New Delhi [illegible]

[illegible] reflect a few examples of my own scientific temper [illegible] human affairs [illegible] which I was able to both report and publish.

A.K.N.

[illegible]

A Token of Thanks

First and foremost I want to thank my Father for sending me from Berlin to London in September 1933 and I therefore escaped the Nazi terrors. I deeply regret that he never saw the results of his wisdom and foresight. I have tried to follow his example, his spirit of liberal tolerance, his unselfish devotion to work for the benefit of others, and his great dedication to culture and science.

Much later I met Stefanie Maison who became my partner in life and who gave me the love and all-embracing help without which I could not have written this book. I can never be grateful enough for all the happiness she gave me.

My sincere gratitude goes to the many scientists who gave me their time, talking to me about their work, or writing about their research; most of them are mentioned in this book by name. A special thankyou goes to Romila Thapar for her Foreword.

I also appreciate the great ease which my Macintosh Powerbook, my first electronic aid, afforded me in writing this book, as compared to my previous mechanical typing experience. But my computer would not always co-operate with me, and I was sometimes forced to capitulate. However, two good friends, Gunter Heyden in London and Dr Volker Thewalt in Wiesenbach, came to my rescue, and I should like to thank them both.

Last, but not least, I am very grateful to the team of the Universitätsverlag C. Winter Heidelberg, the oldest in the town, tracing its origin back to 1801, a period when they published the books of Justus von Liebig.

Two hundred years later, their task of converting my computer disks into this elegant book was no doubt equally onerous, and I would like to thank Ruprecht Schulze, Eilert Erfling and Gisbert Pisch, as well as Olaf Lange and the excellent Designer, very much for their efforts on my behalf.

I enjoyed the professional knowledge and skill of Margit Roth-Fein which ensured the accuracy of the Indexes, and for that I am most grateful to her.

Foreword

Professor Romila Thapar, Emeritus, Ancient Indian History, Jawaharlal Nehru University, New Delhi, and a Member of the ISR Editorial Board.
Author's Collection.

Foreword

It is indeed a privilege and a pleasure for me that Dr Anthony Michaelis has asked me to write a Foreword to this book. I am a historian and not a scientist and the justification for my writing this Foreword is, (as he has reminded me), that I am his oldest academic friend.

I met Anthony Michaelis in 1957 when he was editing *Discovery.* I had returned from a brief visit to a couple of historical and archaeological sites in China and he asked me to contribute an article on the subject. Getting to know him involved much discussion on science and its contribution to human civilisation. He insisted that science, if properly used, could be immensely beneficial to human society. I had some reservations about the possibility of monitoring science, given the kinds of ambitions nurtured by those who have used it unwisely. But if it could be monitored then the best fantasies of science fiction would cease to be fiction. This was all part of an on-going discussion that took place over the years on my occasional visits to London and his to Delhi.

I was also intrigued by the range of his interests, reflected in part by the many scientific objects that he collected. Some were easily identified but others were puzzling pieces of earlier technologies.

It was in a sense this range of interests that prompted him to think of the idea of a journal based on interdisciplinary research. In this case it meant the inter-weaving of ideas into and from science, through various disciplines, both from the sciences and from the humanities. Many of us were intellectually excited by the Journal, which in its own special way, was doing what Anthony Michaelis always believed in — the possibilities of a creative use of science: in fact a fundamental aspect of what has been called a Scientific Temper.

For those of us who have been his friend over many years,* reading his autobiography is to recall conversations with him. But even more than that it is to recognise once again the high quality of his commitment to the human good.

April 2001 Romila Thapar

* See Title 341.

Foreword

It is indeed a privilege and a pleasure for me to [illegible]

[illegible]

It was in a sense the range of interests that prompted [illegible] the idea of a journal based on interdisciplinary research. In [illegible] the inter-weaving of ideas into and from science, through [illegible] both from the sciences and from the humanities. Many of us were [illegible] by the journal, which in its own special way, was doing what [illegible] always achieved in [illegible] the possibilities of [illegible] fundamental aspect of what has been called a Scientific Temper.

For those of us who have been [illegible] reading his [illegible] once again the high quality of his commitment to the human [illegible]

April [illegible] Romila Thap[illegible]

[illegible]

For Julia and Ellen, for Stephen and Ian

Short Synopsis

(For a full Synopsis see Appendix III)

Prolegomena

Sir Hans Krebs FRS, Nobel Laureate 1953, was a Member of the ISR Editorial Board until he died in 1981. He will always be counted among the greatest scientists of the Century as he found the all-important citric-acid-cycle in nature which is now called the 'Krebs Cycle' in his honour. This cycle of basic biochemical reactions not only involves the degradation and energy production, but also synthesis of biomolecules and is fundamental to the metabolism of all animals, plants and many microbes.

I knew Hans well, he had, as I did, emigrated from Germany in 1933 and as I did, worked at Sheffield University, where I first met him.

Medal struck by the Paris Mint, Author's Collection.

I kept six honest serving men
(They taught me all I know)
Their names are What and Why and When
And How and Where and Who
Rudyard Kipling *Just so Stories* 1902

What

This book is not an ordinary book. It can of course be read like any normal book, beginning at page 1 and finished at the last page. But, in addition, it has been conceived and written like a 'Newspaper'. A single science story, a Title of special interest to the reader, can be selected from the Synopsis and the Index, read, and is completed on one single page. Some duplication was therefore unavoidable. Each story deals with science and is an example of the Scientific Temper. I have included a few personal reminiscences.

Why

I have written this book because I had a most interesting and rewarding life, and I hope that my example may inspire young people to follow a scientific career. I am convinced that a knowledge of science will for now, and at least for the next century, be essential for any cultured human being.

When

It is perhaps also unusual that I can recount the progress of science of almost the complete 20th century. During this period the discovery of atomic energy, of computers and information technology, as well as spaceflight to the Moon, were first achieved by men. These events are history.

How

If at all possible, I have tried to be present in person, as actual witness, to the science stories here recorded, to interview the scientist and to publish, as soon as possible, the facts with my comments.

Where

Luck brought me a life full of travel, even to the South Pole, to the great Dominions of the British Commonwealth, frequently to the USA and often to Europe, the major part by official invitation. Unfortunately I was unable to visit either Russia, nor China or Japan.

Who

I had the chance of meeting some of the greatest scientists of the century and found them humble and unpretentious, an example I have tried to follow. I met much tolerance and made many friends all over the world who helped me in my work. I am very grateful to them.

Title 2

In 1945, the corner house No. **10 Landgrafen Strasse** was reduced to a heap of bricks and rubble, only the unharmed frontwall to the street remained, including the balcony. My parents had lived on the first floor for over 30 years and **I was born there**. Note also the undamaged iron column for advertising posters, typical for Berlin since 1854, introduced by E. Litfass and named after him. © *Author's photograph*

I am now 85 years old, and it is high time to publish my own story. My aim is to make all description as visual and vivid as possible. This good advice was given to me when in a train from Berlin to Frankfurt I met an elderly gentleman with whom I started a conversation. Comfortably seated, first class, smoking a small cigar, as it was then my custom, I soon learnt that he was a senior member of a well-known German publishing house, whose responsibility it was to choose manuscripts for publication. So I asked him if he could recommend any good book about *How to write an autobiography.* "This I cannot do" he said "there are none, but if I can advise you, make whatever you write as vivid and visual as possible". I have tried.

In the old Western part of Berlin there still is today a street, called Landgrafen Strasse, which on one side terminates at a canal and which had at the other end a post office, Berlin W 62, but that was before World War II. Now the post office has gone and has been replaced by a hotel. Both street and canal date from the boom times after the 1870-1871 War, which Prussia won against France. Solid, quiet and with trees all along its short length, the houses in the street had three or four floors of large apartments for middle class professionals.

Behind the houses were courtyards with entrances to stairs reserved for servants and suppliers who had to use them.These were the class-distinctions of the period. I was born on 22 August 1916 at Number 10 Landgrafen Strasse. It was a beautiful house, at the corner where the street met the Landwehr Canal. Half our windows overlooked the canal which, like the street, was lined with large trees on both banks.

When in 1945 I saw this corner again for the first time after the War, our old house had gone and all that remained was a desolate heap of bricks, stones and the unshattered front-wall. The canal was choked with rubble, the fine trees cut down for fire wood, a typical scene of destruction in many parts of Europe..In the new boom years of the 1950s and the 1960s, Berlin was rebuilt. I then wondered whether this time it will last for centuries, or again only for a few decades until the next, the atomic, war.

I could not have had a more pleasant beginning to my life, although 1916 was in the middle of World War I. My father, Dr Walter Michaelis, a well-known and highly successful doctor, was by then wearing military uniform and was stationed in German-occupied Brussels, working in a military hospital. He was not called up until after my birth. I have a precious bundle of letters, exchanged between my father in Brussels and my mother in Berlin during World War I, and I shall describe them in some detail later. [See Appendix I, Title 420]

When I was 17 a great change occurred in my life, I had to leave my home in the Landgrafen Strasse. Hitler had come to power in March 1933, and soon it was discovered that with my three Jewish grand-parents I would never have a chance to study science in Germany, nor ever find a good job. My mother had died of pneumonia in 1929 and my father, with quite outstanding wisdom and foresight, sent me to live in England on 16 October 1933. It was my first journey outside Germany, from Berlin to London. I went by steam train to Hoek van Holland, by night ferry to Harwich, and again by steam train to Liverpool Street Station in London.

This was all a great adventure to me, and I kept a full diary at the time from which I can now quote. It is small cardboard booklet, covered in striped red and brown paper, containing 76 handwritten pages. It starts with my departure from Berlin at 13.38 hours from the Railway Station at the Zoo. The first pages are detailed daily entries of people and events, later they record only more significant occurrences in my life and then they are blank.

I started again to record what happened to me in September 1938 when the long awaited war seemed to begin. However, Mr Chamberlain, then British Prime Minister, proclaimed on his return from meeting Hitler in Munich "Peace in our time". He grossly misjudged Hitler, and 'our time' lasted just one short year. When the first air raid sirens began to howl in London in September 1939—a false alarm—my diary started again. But this time it was typed and I continued my entries till 10 May 1940, when I was interned as an 'Enemy Alien'. [Titles 17 to 24].

I have a further few typed sheets, dated Mosman, New South Wales, Australia, July 1954, the date I left the Southern Hemisphere again to return to London. It starts: "To read one's own diary with pleasure requires conceit and vanity, both of which I have."It still gives me pleasure, but to tell all details here would be extremely boring to the reader. Suffice it to say that after my marriage in 1946, my wife Ann and I decided in 1950 that a third World War, definitely an atomic one, was inevitable and that for the safety of ourselves and particularly for our children's future, the Southern Hemisphere would be safer than the Northern one. We decided to emigrate to Australia.

We had spent our honeymoon in 1946 by travelling with the then unique Imperial Airways Flying Boat Service, to Australia and New Zealand. We liked what we saw and decided to leave before it would be too late.[See Titles 44 to 46] My experience of leaving Germany in 1933 was decisive. In this context. I always think of Nevil Shute's *'On the Beach'* first published 1957 in which he describes the atomic war in the Southern Hemisphere: "This is the way the world ends".

Falk, my Lutheran Faith, School Science Title 4

My walk to school every morning, with my satchel on my back, took me along the Lützow Strasse to the Falk Real Gymnasium. This, in all its old ugliness has remained unchanged to this day, just as I remembered it. It has only changed its name, Falk is perhaps rightly now forgotten, and the school has received a bureaucratic number. A square five-floor brick building with windows in five horizontal rows, it was opened in 1880, hence also its association with Falk.

During the first day at any school, one might expect that new boys would be told about the name, history and foundation of the awe-inspiring institution to which they had been admitted, bribed and cajoled perhaps by their parents. But not so in the still Prussian Berlin of the 1920s. I never knew who Falk was and therefore decided to look him up in the *Encyclopaedia Britannica*. Adalbert Falk [1827-1900], a Prussian bureaucrat, was the State Minister for Ecclesiastical Affairs under Bismarck in the newly founded German Reich of 1871. Falk was responsible for the *Kulturkampf* against the Roman Catholic Church.

I very much doubt whether his activities had a subconscious influence on me and made me into a life-long critic of that schism of Christianity. I was christened on 30 March 1917 in the Lutheran faith at the famous Dom Cathedral in Berlin and later confirmed in it at the Zwölf-Apostel Kirche, also in West Berlin. When I visited it after World War II, it was still standing as a red brick edifice, but when I called on the vicar he could only tell me that all books and records of his church had been destroyed during the war.

No doubt it is due more to my mother's Lutheran influence, than to any religious instruction I ever received, that I have remained a Lutheran all my life. I recommend this faith to all Christians as it is so pure. It places no ecclesiastical hierarchy between the individual and God, its churches are bereft of any seductive art, and thus it strengthened, in me at least, true Christianity.

There was one man at my school who had much to do with my choice of science as my life's endeavour. He was short and rotund, wore spectacles and of course was *Herr Doktor*—my chemistry master, Herr Ober-Studienrat Dr Arthur Kundt. It is a great tribute to the higher German school authorities of the time that such a well qualified chemist was appointed to teach his discipline to school boys of 10 to 17 years of age. For me his lessons were all-absorbing, he inspired me, and soon I was helping him to prepare the apparatus for his demonstrations, to wash the glass ware afterwards and I was able to spend time talking to him for hours. I wish I could now talk to Kundt and tell him of my career, I am sure he would be pleased.

This took place at home, not in the school's chemistry laboratory. I must have reached puberty by about 1930, and was naturally intrigued about sex. It was not my father, the doctor, who explained to me the anatomical facts about coitus which everyone wants to know at such an age. This explanation came from an older school boy and took place in the school lavatory, accompanied by gestures with fingers. It could not have been cruder and did not create any desire in me to experiment with a girl.

What intrigued me at the time were the self-ejaculations at night, which had become a not unusual event. If the lavatory explanation had been correct, these ejaculations must have contained my own sperms and they might become visible under a microscope. Nothing was easier, as my father had one for his medical tests. These were carried out behind a mysterious screen in his consulting room. There, test tubes in a small rack were ready for simple urine analysis. This room contained at the same time his large medical library, his desk, a sofa, and a round table in the corner for other, social events.

All I needed to do was to produce an ejaculation, and transfer a small sample unto a glass slide to be put under the microscope. I was utterly amazed by the sight of uncountable spermatozoa wiggling and jiggling for an indefinite time, as it seemed to me—they would of course have died in due course. My father must have been visiting patients at the time of this truly remarkable revelation—I am sure he would have encouraged me in this experiment, as he was a man of great liberal views and had always helped me in my work, whatever it was.

I can only assume now that the encouragement I received from my chemistry master at school and from my father at home, were the decisive factors which turned the boyhood curiosity later in life into a university study of science. And even much later, after receiving a Bachelor of Science degree and then a Ph D, not without some difficulties, I always retained my basic curiosity. This characteristic is of course one of the most essential qualifications for a scientist, asking forever what, why and how, as Kipling expressed it so well in his verse. [See Prolegomena, Title 1]

I was never interested in making money to become rich, to buy large and fast cars, although once I was given a superb classic model, a Lagonda, which my wife gave me as a wedding present. (It cost £ 1000 in 1945). For many years it gave Ann and me great pleasure. But in spite of being relatively poor, I have had 85 years of the most interesting life that any curious scientist can have. Perhaps reading this tale may persuade others to follow a scientific career!

Rich Chemists and how they enjoyed their Wealth Title 6

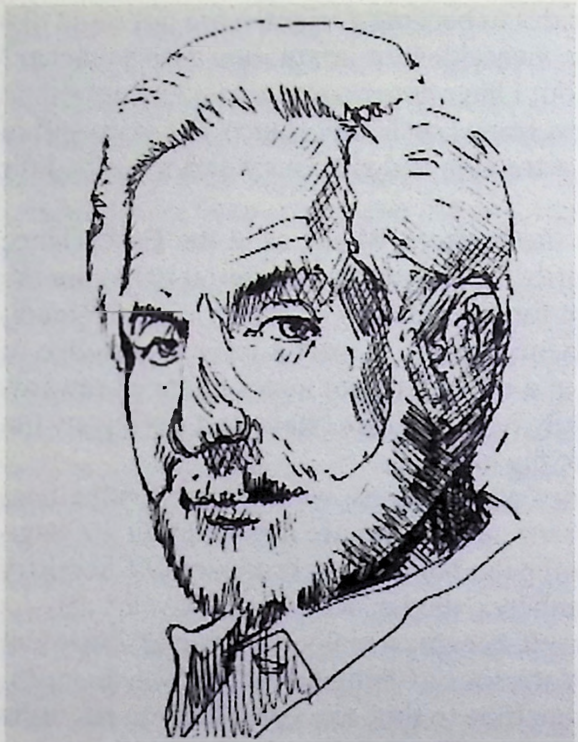
The reasons why a young boy or girl decides to become a scientist are not often discussed. Nature or Nurture? Pure chance, an accident or infatuation with a teacher? There may well be many other reasons, but I have never come across any published research into that question which has now gained such importance. For many gifted young persons, science has now lost the attraction and glamour which it has had for the last 100 years.

Strictly speaking this is only true for the Western World, as in the East science and engineering careers are still the priority for the young. If material riches are the life's aim, the young in the West will opt for accountancy or law, or even for medicine in certain countries. To take up science means at least a basic knowledge of mathematics, always very hard studies at a university, but never financial rewards later in their careers. The number of really rich scientists I have met during my life can literally be counted on the fingers of my hand.

Three rich chemists, who became very good friends, were Franz Sondheimer, Arthur John Birch and Carl Djerassi. Franz and Arthur are now dead. Franz tragically committing suicide, Arthur after being the Foundation Professor of Chemistry at Australia's National University in Canberra, died peacefully a few years ago.

Franz, or Frank as he often called himself, became a really close friend. I first met him in Israel where he had become a Professor of Chemistry at the Weizmann Institute in Rehovot and which I visited from time to time as a consultant on scientific public relations. Here follows a brief note how Frank spent a great deal of money after I introduced him to the passion of collecting. By then I myself was an ardent collector of antique scientific books, which of course I showed to Frank with some pride.

He then decided to do the same, but only to collect first editions of classic chemistry books which had been written by such great chemists as the Hon. Robert Boyle [1627-1691]. Even in London these treasures were difficult to find, and often cost several hundred, if not thousands of pounds sterling. After a few years, and after having splendid bookcases built for them in his Mayfair flat—Frank had by then become Royal Society Research Professor at University College, London—he had built up a superb collection of the history of chemistry. All were *editio princeps*, many of them in original bindings, often of antique leather and rebound if necessary. His magnificent collection was unique in private hands and it gave him great pleasure, as his wealth allowed him to enrich his knowledge and his life through it. Unfortunately after his death, the collection was dispersed by auction, only the Collection of books by Boyle found its way to an American University.



Title 7

Professor Carl Djerassi, a Member of the ISR Editional Board, has added a literary career to his other achievements and calls his genre "science-in-fiction", imparting his stories with scientific facts. *Artist: Peter Lightfoot, Courtesy David Fishlock, R&D Efficiency.*

Carl Djerassi enjoyed his wealth in a different way, collecting something else, as for example Degas sculptures as he described in his two autobiographies. He also set up a foundation in California for young artists, and has now started a new career as an author, writing novels about contemporary scientists; he calls his series *fiction in science.* He is of course carrying on as Professor of Chemistry at Stanford University in California. His writing of novels takes place in a small flat in London where he feels free from the scientific and social duties of his university. Like Frank he has made excellent use of his wealth, enjoying the great freedom he achieved, through being independent.

John Arthur Birch, the third of my rich chemist-friends, was born in Australia and had a hard life, his father being a pastry cook at a leading Sydney Hotel, and after his death, his mother worked hard to finance Arthur's university studies. Once started on his chemical career he achieved early fame through the discovery of a chemical reduction reaction, ever since called after him, the 'Birch Reaction'. For any scientist to have a discovery linked to his name is a very rare event(except in Biology)and in the special hierarchy of scientific honours, a named discovery comes not far after receiving the Nobel Prize.

I do not know of any special way in which Arthur really enjoyed his wealth, if not through his frequent world wide first-class travels. He built for himself and his family a lovely house in one of Canberra's best suburbs, as luxuriously as he could, in Yarralumla, the Diplomatic quarter of Canberra, Australia's capital garden city. In the centre of the large house, it had a courtyard in the Spanish style in which there was a great swimming pool and thus he, and of course his guests, could step straight from their bedrooms into the pool—a pleasure which I was often able to enjoy.

All three, Frank, Carl and Arthur, were the leading research chemists at Syntex, the company which developed the birth control pill. As they were highly successful, the Company's shares increased in value, they were divided and rose again, divided again, and thus those who had invested in their own work grew rich. Indeed a very rare tale and here included because it is the exception that proves the rule: Scientists never take up their careers in order to make money. It can happen, and must have happened also in the past, but more likely for engineers in the 19th century.

My further Education — Title 8

Being a perfectly normal young scientist I followed the rule and decided to study Aeronautical Engineering, by no means in order to become rich. My aims were quite different when in 1934 I entered Imperial College, London University, in South Kensington. I was then full of hatred towards the Nazi Regime which had driven me from my home and forced me to leave my father. There was at that time no knowledge of any Concentration Camps. Aeronautical Engineering would give me the chance, after completing my studies, to design and build military aircraft which would fly from England to destroy the enemy. But before 'going up to university', as it was then called, I had to work harder than I had ever done before or since.

I arrived in London on 14 October 1933 with only a schoolboy's knowledge of English. As a curious fact, my English teacher at the Berlin school gave me on my School leaving certificate the note 'quite unsatisfactory'. Whatever I thought then about this Nazi, I had to pass the Matriculation Examination for Entrance to London University within 9 months, quite apart from learning a new language, English, up to University standard.

Only later I heard that I would also have to pass two English examination papers. One of them was devoted to English literature and I had to know, practically by heart, Shakespeare's *King Henry IV, Part II*, Lady Stanhope's *Eothen* [a 19th century travel book of the Middle East], and the first two chapters of Milton's *Paradise Lost.* The second English paper was more general, but I cannot remember now its exact questions. I passed.

I shall forever be grateful to Mr Lucian Oldershaw MA who taught me not only a new language in such a short time, but held equally liberal views as my father—I was indeed lucky in having two such marvellous men as my paragons. Mr Oldershaw had been a Don at Oxford University, but later in his life set up a cramming establishment in Maidenhead, about 20 kilometers away, where he coached Oxford students who had failed their exams. He was an excellent teacher, kind and with inexhaustible patience.

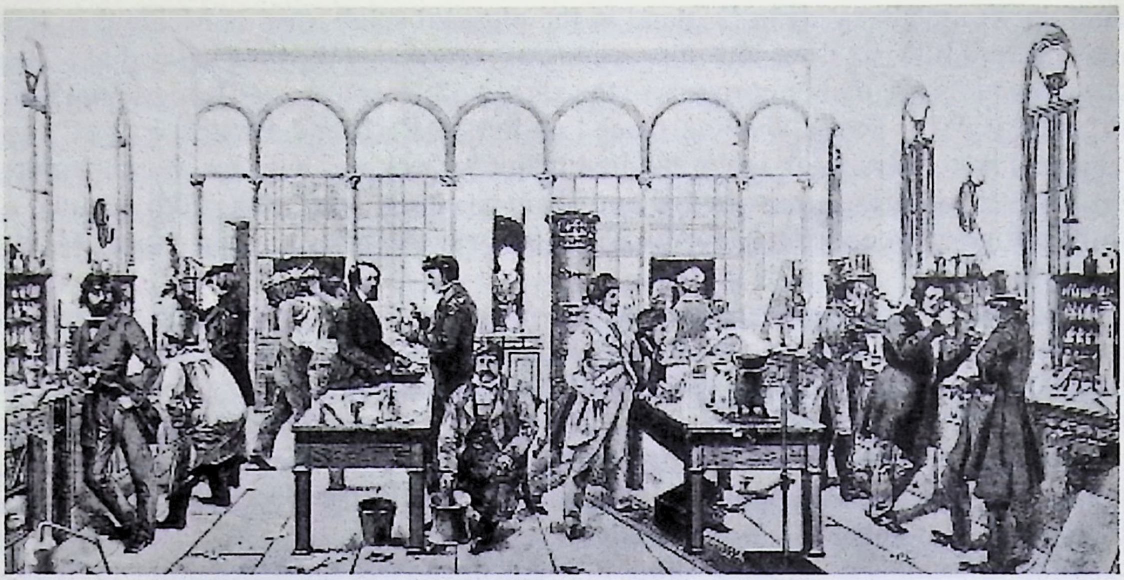
He was a member of the liberal party and tried to enter Parliament, but failed. He was more successful in local politics and was elected Mayor of Maidenhead. I lived in his large house, called 'Fernley' and had all meals with him, his wife and their three children, where of course only English was spoken. Still I had great fears of the June 1934 exams for which I worked, waking or sleeping. He engaged a colleague of his, an engineer, to coach me in 'Mechanics' and 'Heat, Light and Sound', a course in basic physics one might call it today.

As I spent my first year in England in the pleasant small town of Maidenhead, it may be well to write down my impressions, as recorded at the time in my diary. The town owed its original importance to the narrow 18th century road bridge, on which the Great West Road, leading from London to Bath and Bristol, crossed the Thames. A century later, when the first major railway was built for the same purpose, a second bridge was needed and again a century later in the 20th century, a third bridge was needed for the M 4, the Motorway. All bridges are in or near Maidenhead.

I was much impressed by its closeness to Windsor, the royal residence, only a few miles [the English mile equals 1.6 km] away. Maidenhead had a High Street running from West to East which already in the 1930s was a One-Way Street, then extremely rare. Traffic in the opposite direction had to use a long circuitous route, past the only cinema and the railway station, which had the town's bicycle repair shop opposite. This was a most important location for me, as my bicycle was not infrequently in need of attention.

One of the most prestigious shops in Maidenhead was the jeweller and antiques purveyor to Her Majesty Queen Mary, the Queen Mother at the time, a real Edwardian lady. Having obtained the Royal Warrant for his shop and proudly displaying it above the shop window, the poor jeweller had to suffer for it. Queen Mary who sometimes drove over from nearby Windsor, where she lived, was in the habit of strolling round the antiques and pointed with her umbrella which she always carried, weather fair or foul, to an object she liked and said "Send it over to Windsor". This was of course a royal command for the jeweller and to be carried out immediately, although he knew very well that he might have to wait many months before he was paid for it! (I knew this intimate detail from the jeweller's daughter whom I invited to the cinema and a cup of tea, whenever I could afford it.)

When writing these few lines about Queen Mary, I was sufficiently intrigued to look her up in the *Encyclopaedia Britannica*. I learnt that her name was Mary of Teck, in full: Victoria Mary Augusta Louise Olga Pauline Claudine Agnes [1867-1953]. In 1893 she married George V who became King in 1910. The *E.B.* continues: 'Her intellect, good sense and artistic taste and her concern for the servicemen of World Wars I and II fitted her to be the wife of a Sovereign and to make her popular with all classes of the British.' Except perhaps the unlucky jeweller in Maidenhead.



Title 10

The first Professor of Chemistry in England was August Wilhelm **Hofmann** (later von) FRS (1818–1892), seen as the first on the right in this contemporary (1840) drawing by Trautschold and von Ritgen, showing **Liebig**'s original chemical Laboratory in Giessen. In 1845 Hofmann was appointed Professor in the new Royal College of Chemistry in London, following the advice of Liebig to **Prince Albert**. Hofmann's twenty years of teaching and research at the College were vital to the development of Chemistry in England. The College was later re-named Royal College of Science, where the author studied chemistry from 1934 on and was awarded the Associateship of Royal College of Science, the ARCS, in 1937. He is proud of this direct 'link' with Justus von Liebig. *Courtesy the University of Giessen.*

Liebig and the Imperial College, London Title 10

The Imperial College of Science and Technology, to give it its full name until after the end of World War II, when 'Medicine' was added, consisted in my days, the 1930s, of its three constituent Colleges: The City and Guilds Engineering College, The Royal College of Science and The School of Mines. Imperial College dates back to 1910, although the Royal College of Science was much older.

It grew from the The Royal College of Chemistry, founded as the first chemistry teaching establishment in England in 1845. It was Prince Albert who wrote to Justus von Liebig, Professor of Chemistry in Giessen, asking him to recommend an outstanding pupil to head the new College. Liebig in his reply suggested none other than his own Assistant, August Wilhelm Hofmann [1818-1892], elected FRS in 1851, later von Hofmann. He was appointed the first Professor of Chemistry in England. He lectured at, and was Director of the New College of Chemistry in London and his twenty years of teaching organic chemistry there made him one of the most influential teachers of the 19th century. Contemporary illustrations of Liebig's 'Institute' show Hofmann among Liebig's elegant students wearing top-hats and frock coats.

There can be no doubt that all chemistry laboratories in the world are direct descendants of the original Liebig laboratory, the 'Institute' of 1840 in Giessen, and that Liebig may rightly be called the founder of the practical philosophy of modern research chemistry in addition to his other great fame as the originator of agricultural chemistry by fertilisers.

I entered the City and Guilds College as an undergraduate in 1934 to study aeronautical engineering. However, this was a postgraduate subject, and I had to follow the First-Year curriculum like every other student of engineering. One of its highlights was the Wednesday afternoon practical course in the large engineering workshops below street level. There we found a number of excellent foremen who could make the simple—sounding 'filing-flat' into an exasperating exercise of trying to reach perfection. It is a skill that can be learnt only after weeks and months of application, and was in the 1930s still considered essential for a good engineer I never mastered it.

Another memory I have of my first academic days was the inauguration address by the Dean of Engineering. He told about 300 first-year engineering students: "Never refuse a to do an engineering job, even if it will give you dirty hands, you will always learn something and you can easily wash them afterwards." My failure at the end of the first year was my mathematics examination and I decided to study chemistry instead at the Royal College of Science where my first year's study in engineering was fully recognised and where there was no further need for much detailed mathematics.

The Inorganic Chemistry Department of Imperial College was still under the benevolent supervision of Professor J.C. Philip FRS while I was a student there in 1935. Around 1910, before World War I, as it was then part of proper education, he had studied chemistry in Heidelberg and Göttingen, and ever since it was his wish that, what he had learnt in Germany during his student days, should also benefit his own students in London.

One of his principles was that, in addition to teaching chemistry in the strict classical manner and with immaculate laboratory etiquette, he should have some personal contact with, and knowledge of, his students. To achieve this, there was a monthly tea party in his large house in Queens Gate, a broad tree-lined avenue next to the College, where he and his wife received about a dozen third-year students. He was the only professor of Imperial College who took this trouble and this small contact was much appreciated, although I doubt if it had much influence on my behaviour.

During my four years as a student at Imperial College, I lived the first two years at the College Union, a pretty grim, but utilitarian Hostel. Small rooms with bed and washbasin, table and chair, and book shelves; but a bathroom with facilities was only at the end of a long corridor. One night, I do not remember where or with whom, I must have had too much to drink. I got back to my room and was sick on the floor. This must have been reported to the Warden, a totally uninspiring ex-chemistry tutor, who had been demoted to the position of Warden. He threatened me with expulsion from the Hostel, if ever I repeated such "despicable misbehaviour". His warning made a deep impression on me at the time, and ever since then, in 1935, I can only remember one further instance of being completely drunk. I was still a student a year or so later and in Lyon, France, where I fell victim to absinthe, a drink I have avoided ever since.

I worked hard again to pass the final exams in Chemistry with Botany as a subsidiary subject and in 1936 I could proudly write B.Sc. and A.R.C.S. (Associate of the Royal College of Science) behind my name. In the four months of holiday which followed the final exams, I worked for part of the time in the private laboratory of a Dr Rudolf Lessing, determining the fluorine contents in coal dust, as parts per 10 million. Another month was spent idyllically with my father whom I met in the Sporthotel Parsenn in Klosters, Switzerland. My diary tells me that we were both very happy together.

Happy Holidays Title 12

The earliest holiday of my life which I can now remember had a very dramatic ending and that is the reason why I can still recall it. I was 8 years old in 1924. It must have been the first real holiday for my parents after the hard times of World War I and the hyper-inflation which had struck Germany in the early 1920s. My parents took me to a small hotel in the forests of Thuringia, not more than a few hours train ride from Berlin. By then, in 1924, my father had lost all his savings twice, once through the worthless War Loans in 1918 and secondly through the inflation, so our holiday must have been a simple and cheap one.

I often heard from my mother that during the days of inflation, how she was waiting at the entrance to the house where my father was visiting a patient who had paid him in cash. She took immediately the bundle of banknotes—first thousands of Marks, later millions and in the end billions—and bought the essential provisions for the next day's meals, before the money ceased to be worth the paper on which it had been printed. The inflation ended in November 1923 and hence I am certain that our holiday was in the summer of 1924, when I was 8 years old.

It was a happy holiday and in the forest we discovered a small brook. My father decided that it would be fun for me, and also instructive, if we built a dam across the brook from the stones lying around. This we completed but later I had some pains in my groin which my father took very seriously. The next morning he announced that he had been called to an urgent consultation in Berlin and that we would return at once. At the Berlin railway station I became suspicious, as the son of one my father's colleagues was waiting for us with an ambulance on the platform. Within the hour I was in the private hospital of my father's colleague, the surgeon Professor Unger, anaesthetised and operated for an acute appendicitis. All went well, and soon I was back at school.

By the next year 1925, family finances must have been much improved and we spent the Easter Holidays from 8-20 April at the then large and famous Hotel Wittebrugh near Scheveningen in Holland. My parents took me to the great museums, the Mauritshuis, the Rijksmuseum in Amsterdam, to Leiden and to Harlem. Then in the summer we went to Rigi-Klösterli in Switzerland.

I still have my own diary of the four weeks we enjoyed there, the walks, the train trips on the rack-and-pinion railways and the steamer excursions—a day by day record with many postcards stuck in. Re-reading it 70 years later, I enjoyed these reminiscences, but I doubt if they would mean anything to the reader.

It was expected in those days that any serious chemistry student would continue his vocation by trying to obtain a doctor's degree in his subject from his University, London in my case. Such a degree is still called in Latin to this day a Ph D *[Philosophiae doctoris]* in many, but not all Universities. This was also my wish, but of course finance for a further two years of academic life had to be secured. As my father was not allowed to transfer any money abroad from Germany, he had to use a subterfuge. He had a rich American patient, who was most kindly prepared to send me an allowance of £ 5 a week and to receive the equivalent in German Marks from my father while the American benefactor's business kept him in Berlin. I wish I had been told his name or anything else about him — I never met him — in order to thank him later, but this was not possible.

The first step, after a promise from my father that my weekly £ 5 would continue even after graduation, was to find what the Germans call so aptly a *Doktorvater,* a senior lecturer or Professor who was prepared to teach a raw graduate the mysteries of chemical research. Of course he himself would gain from this arrangement, as he would obtain, without a fee, an assistant in his own chemical research. A gamble for both parties of course, but one that has stood the passage of time, and there seem to be few cases where it has not worked very well.

I was lucky that a Senior Lecturer, R. Patrick Linstead, was prepared to take me on. R.P.L. as we used to call him, was working on phthalocyanines, a strong and deep blue pigment, which was precipitated from concentrated sulphuric acid and hence extremely stable. I believe he had a grant for his research from ICI, the famous Imperial Chemical Industries who must have been very satisfied with his results. These phthalocyanines, eventually available in many different colours, formed the basis for the colours sprayed onto automobiles, a very large market for ICI. One small sub-subject in his researches was the question of de-hydrogenation, and that was allocated to me.

In November 1939, when I had typed my thesis, it was submitted to London University. It was entitled: *The Dehydrogenation of alicyclic Compounds and terpenic Ketones in the liquid Phase.* After an oral examination by two external examiners of London University, as R.P.L. was by then Professor of Chemistry at Harvard University, and of course could not return for my 'oral' as World War II had started, I was awarded my Ph D. Part of my thesis was published in a joint paper with R.P.L. in the the *Journal of the Chemical Society, London* in 1941. [See Appendix II, Bibliography, Title 428]

The 'Prof' and the Ph D Title 14

Sir Reginald Patrick Linstead was a very distinguished organic Chemist. He was of small stature and the most prominent feature of his appearance was an extremely large forehead. He was always soberly dressed in a dark blue lounge suit with a narrow white stripe, white shirt and dark tie. I cannot recall that he ever wore the standard white laboratory coat which so clearly indicates the status of the organic chemist. Was it colourful with yellow acid stains and torn at the edges, or even reduced to a small jacket length, then its owner was a very active, but not necessarily a good chemist. If the lab coat was spotless and virgin white, then the opposite was true and thus one would expect the Prof to be so dressed, but not RPL. After a relatively short time he was elected a Fellow of the Royal Society and he finally became the Rector of Imperial College. Sadly, I never met him again after I left College, as I liked, respected and admired him. Later he was knighted and became Sir Patrick. I also met Lady Linstead, who had her own profession, not chemistry, and was always full of charm and kindness to her husband's students.

When I was interned in Canada during the war, RPL sent me a letter dated 18 November 1940 from the Department of Chemistry, Harvard University, Oxford Street, Cambridge MA to Camp L, Base Army Post Office, Ottawa, Canada. This letter, which I have in front of me now, contained a testimonial from which I quote

> Dr Michaelis showed himself to be a careful and thorough worker and he has a wide knowledge of chemistry. He is also an excellent linguist. Perhaps it is appropriate for me to add that I found Dr Michaelis a very pleasant and energetic co-worker. Also I believe him to be loyal to England and a good democrat.

It was most kind of RPL to send this testimonial to the English authorities who had interned me. He knew of my predicament, sent me a number of books to Canada and supported my application for release and for return to England.

But was RPL just polite when he called me "thorough" or ignorant of the error I made when using a catalyst during my chemical work for the Ph D? My error was simply to use too little of it, one tenth, and the expected result never occurred—but why this was so, was of course fully discussed at the time with him. He never thought that I would simply use 0.1 gram of the precious palladium catalyst, instead of 1 gram as I should have done.

Soon after I graduated, RPL was appointed to his first Chair at Sheffield University and I followed him. The year I spent there at the University was not very exciting and I was glad to return to London just before the outbreak of World War II.

Throughout history Wars have been given names, often for the length of time they lasted, for the geographical area for which they were fought, or for the succession to a throne—just so that they could be distinguished from the previous, the 'last war', and from the future one, bound to come.The one that I aim to describe and how I was affected by it, "Dad what did you do in the last War?", was the Second World War. Because it extended practically over the whole of Planet Earth, it was rightly named "World War". Because it was, for the second time, fought between Germany representing Central Europe on the one hand, and the Anglo-Saxon countries on the other, representing the rest of the Planet with the exception of Japan, it deserves the name "Second World War ", or W.W.II in short.

As science and technology had progressed greatly during the 30 year interval which separated W.W.I ending in 1918, from the beginning of W.W.II in 1939, the second world war was far more extensive, it was total. The civilian population was deeply involved in all belligerent countries, often exposed to more danger from the air than the military forces on the ground. The very humane conventions of the Geneva Protocol dealing with civilians and P.o.W. were set aside by several belligerents, and thus W.W.II became a far more cruel war. Its prisoners of war, the P.o.Ws. were cruelly exploited in factories for the production of war materials, if not left simply to die from starvation.

Once W.W.II had started, its totality affected science and technology, pressed into service by both sides. The results soon became obvious. Large fleets of military aircraft were designed, developed and built, and once available, ruthlessly employed. As a countermeasure radar was invented, and finally atomic power found its first devastating use in 1945, as bombs on Hiroshima and Nagasaki. All these scientific and technological inventions were later, after the end of W.W.II, modified and found beneficial use in peace time. The only scientific discovery in war time of immediate humanitarian advantage, was penicillin, first found, isolated and employed in England. Another war time novelty was the widespread use of 'Operational Research', later to be called 'interdisciplinary science'. [See ISR Vol 1, No 1, Editorial "Future Affirmative"]

Penicillin reduced, once it was mass-produced in the United States, the inevitable bacterial infections of war wounds to such an extent that millions of soldiers were able to survive who would otherwise have died, as they did from gangrene in W.W.I. On the other hand the suspension of the Geneva Protocol of the Red Cross led to millions of deaths.

The beginning of September 1939 found me in Maidenhead again, standing on the platform of the Railway Station. I had volunteered when the War started to help in the evacuation of children from London, and this I did in Maidenhead where I could stay with the Oldershaws very cheaply. It was not real work carrying a few suitcases and passing on children to lady volunteers who took them to their homes for 'the duration', as the war was then euphemistically called.

By then my father had finally succeeded in leaving Germany and had settled in England. He was at first staying with a friend of his in Buckland Crescent, in London's Hampstead. As I had no job and no income, and as he had for the third time in his life lost all his savings, we were both glad that he had found a home he liked. The first time he lost all his money was at the end of W.W.I when the German war loans became worthless. The second time was during the hyper-inflation of 1922, and the third time when the Nazis allowed him to leave Germany, only on the condition that all his capital in the bank was transferred to a Nazi nominee. [See Titles 425-427]

As a fully qualified medical doctor, but not allowed to practise medicine in England, he was obliged to find a job with a Refugee Organisation which had created a camp for German Jewish children, who had been allowed to come to England without their parents. The Camp, near Norwich, Norfolk, on the East Coast of England, was a large farm which had been converted to house about 350 children. There my father had a few rooms for living and for his practice. As in Berlin he had practised as a paediatrician he was reasonably content. A sad end, however, to his medical career, when among his friends in Berlin he had looked after many distinguished patients, as for example all the Mendelssohn family.

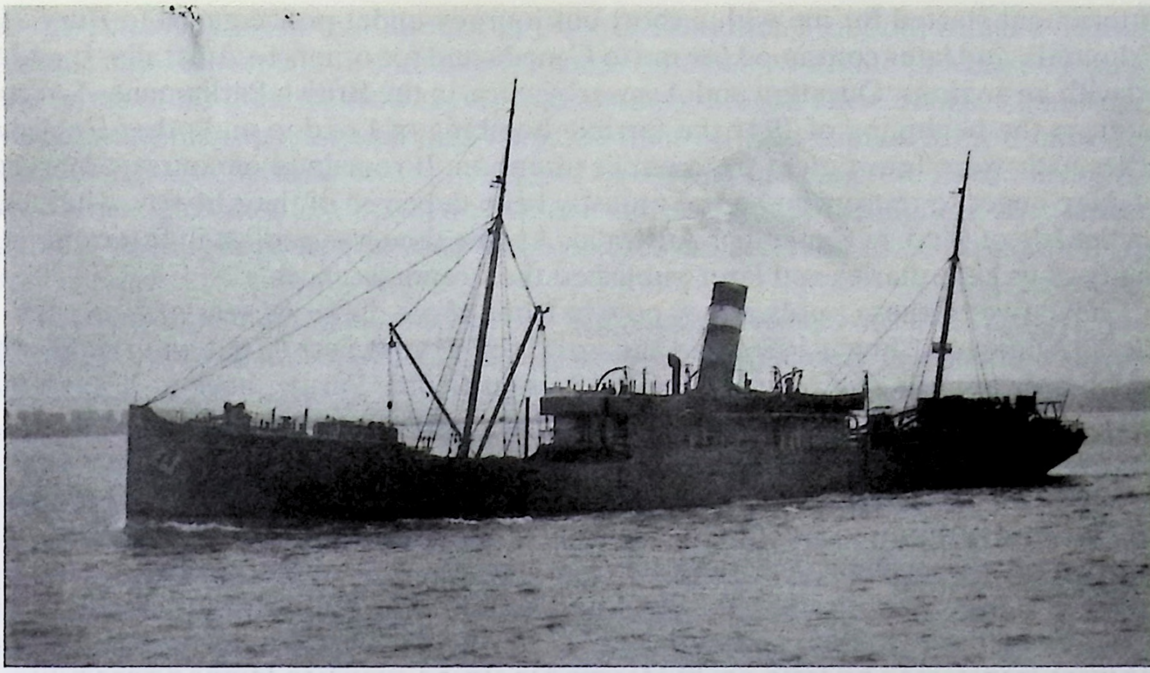
I visited him in the Camp as often as I could, and in the Spring of 1940, when the 'phony war' had stopped and shooting had started, I was with him at the Camp. Hitler's Blitzkrieg had just overrun The Netherlands and Belgium, following the plan of General Schlieffen, unsuccessfully tried in W.W.I. Now, in 1940, German armies succeeded and stood at the Channel Ports opposite England. The British Expeditionary Forces had to be evacuated back to England from Dunkirk and not surprisingly the British Cabinet was obsessed by fear that Hitler would soon attempt to invade England. One of the actions taken was the immediate internment of all "Enemy Aliens" as the Cabinet was afraid of a repetition of the 'Fifth Column' which had helped Franco to capture Madrid during the Spanish Civil War in 1936.

Before the outbreak of W.W.II the fear of a Fifth Column had caused considerable concern in Britain. During the Spanish Civil War, 1936-1939, General Franco advanced with four columns of soldiery on Madrid, and often boasted of his 'Fifth Column' inside the Capital, which spread false rumours and misinformation from their positions of authority, thus reducing the will of the population to resist the attacker. The many German-Jewish refugees, who had been allowed to come to England since Hitler's access to power in 1933, could, in the minds of military intelligence, constitute a perfect Fifth Column, if an Invasion of England was to take place.

To avoid a repetition of the senseless internment of thousands of Germans living in England before the 1914 War, it had been decided in 1939 by the British Cabinet to set up Tribunals under Magistrates to screen and sort out all refugees according to three categories. "A" category were the most suspicious and were interned immediately, "B" category were doubtful and had to register and report regularly to the Police, and "C" were innocent. I was "C" and these Tribunals were universally considered as an enlightened and highly sensible solution of the 'Fifth Column' problem. But this attitude only lasted until the spring of 1940, when the war situation became serious, British troops had to be evacuated from France and an invasion by German Armies became a dangerous probability. It was discovered after the end of the War, that indeed elaborate plans had been made by German generals to attempt such an enterprise.

By May 1940 Winston Churchill had become British Prime Minister and being deeply concerned about security, he was said to have issued his famous, or infamous, instruction about refugees "Collar the Lot". It was the Home Secretary of the time, Sir John Anderson, who was charged with the execution of this order to intern all, irrespective of Category.

It was the unforgettable Sunday 12 May 1940, when, during the early hours of the day, policemen all over Great Britain informed all refugees, even category "C" holders, that they should pack a few things "Just enough for a few days" as the general order was phrased. Although I was not registered at the Camp where I visited my father during the Whitsun weekend, I was caught in the net which extended from the ages of 16 to 60. My father, over 60, escaped and could stay at the camp. I said Goodbye to him "for a few days", but I would never see him again. This I did not know at the time and I thus began my internment with much resentment, as I had been Category "C", but with few real worries.



Title 18

The **SS Ettrick**, the old tramp steamer which, in July 1940, took uncounted hundreds of refugees in its four holds from Liverpool to Quebec in Canada. Overcrowding was grim, but she was not involved in enemy action as her sister transport, the *Arandora Star*, which was sunk. *Courtesy: Commander Simon Cooper, Royal Navy © National Maritime Museum, Greenwich*

Internment—The long Voyage to Canada Title 18

Internment started for me with a short bus journey under police guard to Bury St Edmunds, and later continued for me to Canada and for others to Australia. It ended with an anxious 'Question and Answer' session in the British Parliament. A year later, in the beginning of 1941 the terrible bombing of London and other English cities had swept Internment from public attention. It remained of course a matter of deep anger to those who had so unjustly been deprived of their liberty, whether on the Isle of Man, in Canada or Australia. As free time was endless in Internment, many of us kept diaries and later published their reminiscences.

I have two of these publications now in front of me, "*The Diaries of Harry Seidler*" [Allen and Unwin 1986] and the article by Max Perutz "That was the War" which appeared in *The New Yorker* of 12 August 1985. Perutz, born in Vienna in 1914, and a refugee like myself, is a biochemist who, on returning from internment went to Cambridge, and devoted his research work to the analysis of the haemoglobin structure by means of X-ray crystallography. Thus he elucidated the molecular basis of respiration and in 1962 received the Nobel Prize for Chemistry. During internment we became good friends, as I already knew his wife from Berlin days.

We first met again in the old school hut in Bury St Edmunds where police had taken us both on 12 May. There we slept on a rough concrete floor for a week till we were transferred by train on 20 May under armed guard, to Huyton near Liverpool, to a new and empty housing estate of numerous small one-family units. Beds were provided and apart from the meagre sustenance, mainly porridge and herrings, we were reasonably comfortable for 3 weeks. The next move was to the Isle of Man on 14 June, by one of the regular excursion steamers from the harbour of Liverpool.

As this was to be a permanent site for our Internment—or so it was thought—a quarter of the town of Douglas had been surrounded by barbed wire fencing and we were accommodated in ordinary houses, normally let to holiday tourists. Our 'permanency' lasted for just over 2 weeks, and on 2 July back to Liverpool, where we embarked on the ocean steamer *SS Ettrick.* We landed in Quebec, Canada, on 3 July, after surviving not only the dangers of being torpedoed, but also horrific conditions of overcrowding. Camp L, on the heights of Abraham, high above Quebec, was a holiday home compared with our previous experience in England. In October we were again moved, this time to winter quarters, to Camp N in Sherbrooke, from which I, Perutz and others were released—to travel by train to Halifax and in a large convoy on board the *Thysville,* a Belgian Congo steamer, back to Liverpool, arriving in blacked-out wartime England in January 1941.

I was extremely lucky that already in Bury St Edmunds I met old refugee friends, Walter and Rupert Blum, who had for some time been with me in Maidenhead at the home of Mr Oldershaw. They were studying at Magdalene College, Cambridge, when internment began, and thus they and their refugee friends from Cambridge University, also became my friends, all of us sharing the concrete floor during the first few nights at Bury. Soon we became a close group, throughout the various camps, sticking together, sharing what goodies we received from outside, mostly food parcels.

The most outstanding member of this 'Cambridge Group' was Fritz Lingen. Tall, blond, blue-eyed, and sportive-looking, always immaculately dressed and always clean shaved (by no means a universal characteristic of all). Fritz represented, even under the most adverse and trying conditions, a picture of a gentleman of the good old days. He had of course every right to his appearance and aristocratic behaviour, as he was the youngest son of the German Crown Prince, a Hohenzollern.

He provided the physical leadership when it became necessary to present a complaint to one of the Camp Commandants, who were noticeably impressed by royalty and a Godson of Queen Mary. When it became imperative on the *Ettrick* to clean out the ship's latrines, deep in vomit from seasickness and overflowing with human excretae, Fritz somehow organised a number of gum boots, buckets and brooms and within a couple of hours, all was again clean and proper. I shall never forget this task, my worst of internment.

Lingen was by no means the intellectual leader of our group. There were a number of others, like Max Perutz, Hermann Bondi, Tommy Gold, Peter Trier, Walter Wallich, Paul Feiler and Victor Ross, all of whom achieved great distinction in their later careers through their natural gifts, their intellect and intelligence. Hermann, later Sir Hermann, and Tommy Gold worked out the 'Steady State Theory of the Universe' which for a long time rivalled the 'Big Bang' origin of the Universe. Both were elected Fellows of the Royal Society and became professors, Hermann in Cambridge, England, Tommy at Princeton.

Peter Trier became Director of Research of the Philips Company, Walter Wallich achieved great distinction in the field of broadcasting, first by acting as the founder of the West-Deutscher Rundfunk, and later at the BBC as the originator of "Phone-In" programmes. Paul Feiler, prominent in the Cornish Group of painters, has his work represented in London's Tate Gallery and Victor, who later changed his surname to Ross, became managing director of the British branch of *The Readers Digest.* All remained good friends.

With so many eminent persons deprived of their careers, all of them fervent Anti-Nazis and certainly neither spies nor Fifth Columnists, one must ask if the policy of Internment was a cost-effective war operation in England. If I could only mention a few good friends here, who were prominent in post-war England, many others were so embittered by their treatment, that they never returned from Canada or Australia, emigrated to the USA or stayed in the Southern Hemisphere, where they also achieved distinction, as for example Heinz Arndt, Founder Professor of Economics at the Australian National University in Canberra. He also was a good friend.

Max Perutz—in his above quoted article—summarised the Policy of Internment as:

> *"It is a disheartening story of official callousness, interdepartmental intrigue, newspaper hysteria, public lies, lies told to Parliament and to the Governments of the Dominions and ... decisions taken on grounds other than the real merits of the case ".*

Apart from a very few cases of brutality by the soldiery, almost always immediately punished, there was a total absence of official cruelty or intentional infliction of any suffering. In fact in a printed notice, issued on 1 July 1940 by Lt. Colonel S.W. Slater, Commandant of the Isle of Man Internment Camps, stated explicitly: "A man's internment is not regarded here as a reflection on his character." and "That every man interned on this Island shall be assured that nothing avoidable will be done that might add to his discomfort or unhappiness."

This was official. But fate decided otherwise. The first great tragedy was the sinking by a German U-Boat of the *SS Arandora Star,* which left Liverpool at the same time as her sister ship the *SS Ettrick.* The only difference being that the *Arandora Star* was carrying German and Italian Prisoners of War and not German Jewish refugees to Canada. Unknown thousands were drowned through the action of a German Submarine—'friendly fire'. This tragedy was known to us aboard the *Ettrick* and did not improve our morale. No official numbers of those who sailed on either of these two ships, were ever issued.

The second tragedy I know, which occurred during internment, concerned me personally. I was in Canada by then, Camp L in Quebec, and was one day, early in July, called to the office of the Camp Commandant and officially informed that my father, Dr Walter Michaelis, had died in London. [See Title 21]

This was official, and in far-away Canada I could only wonder of what disease my father had died so suddenly. The true facts of the case became only clear to me weeks after my release from Internment and return to London. Soon after my dramatic removal from the Camp in Norfolk on Whit Sunday 1940, my father too left Norfolk and returned to London where he lived in the private boarding house which had given him shelter and home, when he arrived from Berlin.

As it was customary in England throughout the years of World War II, the BBC transmitted at 9 o'clock in the evening the main news of the day. And so on 4 July 1940 as always, my father listened to the radio and heard a news item that the *Arandora Star* had been sunk in the Irish Sea during the day and that no survivors had been rescued. From the Isle of Man camp, a few days earlier, I had sent my father a telegram that I would shortly be on my way to Canada and he was able to reply in time, giving me names and addresses of his friends in the USA who might be able to help me. This was his last message to me and I still treasure it today.

I can only conclude that my father assumed that I had been on board the *Arandora Star* and had been drowned. At the age of 64, penniless in a foreign country, a widower and his only son dead, with the possibility of himself being interned, he must have felt that there was nothing left for him in life and he committed suicide. On his death certificate, it is stated that two Coroners Inquests had been held, and that the cause of death was 'Luminal poisoning, did kill himself while of unsound mind' as determined by post-mortem. (*Luminal* was a pheno-barbiturate sleeping drug in those days and must have been easily available to him in Berlin before he left for England). This tragic story of my father's death was raised in the British House of Commons and also referred to in an issue of *The Liberal Magazine* here reproduced. [See Title 21 A]

On 15 October 1940 we were transferred from Camp L to Camp N, an empty locomotive shed in Sherbrooke which could easily be heated during the coming Canadian Winter. From there the Cambridge Group and some others were released, and I hoped that the death of my father had some effect on British public opinion. Sir Alexander Patterson, one of H.M. Commissioners of Prisons, was appointed to act and he arrived at Camp N soon afterwards. Walter Wallich was his Godson and these two went through a list of internees and decided who could be immediately returned to England. As soon as the Canadian Military Authorities could arrange it, about 50 internees, including myself, were moved by train to Halifax and hence by sea in convoy back to Liverpool.

THE

LIBERAL MAGAZINE

VOL. XLVIII. JULY-AUGUST, 1940. No. 559

NOTES OF THE MONTH

Friendly Aliens

WE are fighting this war not merely for self-preservation but for a great cause —the cause of freedom. One of our aims is the liberation of the victims of Hitlerism. Obviously, then, our treatment of the friendly aliens who have found refuge here will be large-hearted and generous. Even on the ground of self-interest, we should welcome those who bring gifts of special knowledge and skill, which they are anxious to place at the disposal of this country in its hour of trial. Yet we have to lament that the policy put into operation recently, at the instance of the War Office, was ill-conceived, unjust and, in its application, frequently stupid.

The policy of wholesale internment and, in some cases, of despatch overseas, adopted, admittedly, at a moment of great peril to this country, had sorry—even tragic—results.

Sir Andrew McFadyean, in a letter to the Press on July 9th, gave details of one such case. It concerns a Berlin doctor, a widower, who came to this country for asylum in 1938, and his only son, who, writes Sir Andrew,

> " came to this country in 1933, had become completely English in his ways and outlook ; had received an English education, and had taken distinguished degrees in chemistry. Since the outbreak of war he has striven to find some way in which he could serve this country. I personally advised him that it was his duty, given his qualifications, not to enter the Pioneers.
>
> Tragically enough his father then persuaded him that after all he had better, since this country appeared to have no use for his special attainments, enlist in the Pioneers. He had no chance to do this since he was caught up in the drag-net which was cast over the Eastern Counties on Whit-Sunday and interned.
>
> Last Wednesday the father received a letter saying that his son was being sent to Canada, without a chance of saying farewell. On Thursday morning the father died. The son is on the way to Canada.

Not all the manifestations of official stupidity had such tragic results. But they led to the internment of some of the foremost opponents of Nazism, who had taken refuge in this country.

Fortunately, sane public opinion and action in Parliament by liberal-minded persons has produced a change of policy. But it is still necessary that eternal vigilance should be maintained by all lovers of freedom and justice.

Title 21A

A comment about me in *The Liberal Magazine.*

There was universal condemnation of internment by all 'German-Jewish refugees from Nazi oppression', who had been deprived of their personal liberty in July 1940. The unimaginative treatment by the British Military Authorities was bitterly resented and this lasted until the end—it was much aggravated in Canada and no doubt also in Australia. Many efforts were attempted by the internees themselves to ameliorate their often absurd conditions.

A typical episode was the following: The very mixed background of those in the camps, from royalty and professional soldiers to orthodox Jews, led to bizarre events. As only kosher food was permitted to certain Jews, except in conditions of war, the issue of herrings and porridge in the Huyton Camp was refused. However, a scholarly Rabbi declared that if Jews were besieged in their own town, the laws concerning kosher food could be relaxed, but unfortunately the 'walls' of the Huyton Camp belonged to their enemy. The solution was simple: A deputation called on the Commandant, offered to purchase a few meters of barbed wire for a few shillings, and thus they acquired the legal status of being 'properly besieged' and could eat what was offered.

Not all problems could be so easily solved. On arrival in Canada all refugees were officially classed as 'Prisoners of War' and had thus a few privileges but also many restrictions. According to the various Geneva Conventions governing the treatment of Prisoners of War, they must receive the same food and clothing as the soldiers who captured and guarded them. After the war-time diet to which all had been subjected while interned in England, the situation changed dramatically in Canada. I shall never forget the picture, when on the first Friday in Camp L in Quebec, a truck full of whole salmon arrived, as the correct food for the day in a catholic country. Similarly when the autumn came and thick clothing became essential, all of us were issued with warm woollen outfits, but their blue colour was marked with large red circles on the back of the jackets, as shooting targets for any who might try to escape.

The worst restriction imposed by the Geneva Convention then in force, was the censorship of all mail, incoming and outgoing. Only single sheets of special paper were allowed to be sent out, all prominently printed with 'Prisoner of War Mail'. As these were not acceptable, it was decided to eradicate the printed text and substitute 'Civil Internees Mail'. As all of us were most anxious to inform our relatives at home of our safe arrival in Canada, an obvious imperative after the publicity about the loss of the *Arandora Star;* the resentment rose to fever pitch, when after a few weeks all mail was returned by the censors.

Our legal status was never clearly defined, although we were finally termed 'Prisoners of War Class 2'. The greatest opposition was raised against the original classment on our arrival in Canada as 'Common Criminals' when we were all fingerprinted and photographed with a large three-figure number on our chest. This was, fortunately, soon changed to simple 'Prisoner of War', to which first was added 'Class 2' and finally 'Class 2 Civilians'.

The one and, apparently, the only real spy in our Cambridge Group was Klaus Fuchs, a physicist who betrayed British and American atomic bomb secrets to the Soviet Union. He was arrested in England in 1950, sentenced to 14 years' imprisonment, but released in 1959 for good conduct. He returned to East Germany, where he was born as the son of a Protestant clergyman. In 1960 he became Director of the Central Institute for Nuclear Research at Rosendorf, near Dresden in East Germany. At the age of 21, he had joined the Communist Party and therefore in 1933, when the Nazis came to power, fled to England, worked at the University of Edinburgh and there obtained his doctorate. Interned like all others as 'Enemy Alien', he shared our Canadian experience and on release returned to England, to the University of Birmingham, working there on the theory of an atomic bomb. Later, having become a naturalised British Subject in 1942, he went to Los Alamos in 1943, where he acquired full knowledge of the atomic bomb research and passed this on to the Soviet Union. I remember Klaus Fuchs from Camp L, as often unshaved, never very clean looking, and a rather sullen individual. His case is a typical example of the inefficiency of the British Intelligence Services, during and after World War II.

The most frequently asked question on our release was "What did you do during the endless hours, days and weeks of leisure?" As soon as any immediate necessities like food, clothing and internal Camp hierarchy had been settled, lectures were organised by the great variety of academic scholars in our midst. With paper, typewriters and copying machines freely available in Canada, much time was spent on writing endless applications for release to British, Canadian and US authorities. I still have copies of six, submitted within a few weeks, all without success.

The lighter side of life could also be indulged, a *Camp L Chronicle* soon made its appearance, essays on a variety of subjects appeared and were circulated. A Cabaret was once staged, and even a Musical Questionnaire with prizes of various quantities of tobacco, was composed. In this respect our Camp Life was similar to all other Prisoner of War camps, wherever the conditions were relaxed and amenable. Similarly, when Captain Scott and his comrades were confined during the long dark Antarctic winter in their crowded hut in 1902, they also published a regular Journal: *The South Polar Times,* see Title 51.

Return to London Title 24

Crossing the North Atlantic during World War I and II, meant either a voyage in convoy at the speed of the slowest ship, or in a very fast ship, zig-zagging all the way. Our voyage to Canada was fast, the return slow and fortunately uneventful, being first escorted by Canadian destroyers and later by flying boats of the RAF. In order to earn a little pocket money for cigarettes, I joined the crew of the *SS Thysville* as 'Volunteer Cabin Steward' from 17 December 1940 to 11 January 1941, a total of 25 days. The Master, E.H. Powell certified: "Conduct: Very Good—Ability: Very Good."

As some internees had preferred to remain on the American side of the Atlantic, those of us who braved the attack of German U-boats, were at first envious of our American friends. England in January 1941 was certainly not a very welcoming choice for anyone's future. Fuel and food were severely rationed, a universal black-out was in force and the *Luftwaffe* had resumed its air attacks on London with nightly air raids. It was particularly sad for me, as only then did I learn the full details of my father's death.

I had a girl friend, Sue Donahue, who had written me a few letters during internment, and who lived in London's Portland Place where her American Dentist father had a large house. She was of Irish descent and a Roman Catholic, so I never considered marriage, although we were both very fond of each other. She was studying medicine and as her chemistry knowledge was rather weak, I coached her twice a week in the evening and was often asked to stay for supper.

Later, when the war continued to look bad for England and after her father had died, she returned to the USA, where she medically qualified and took up a successful career as a pathologist. At the time of my return from internment, she was my 'nearest and dearest'. Sue and I remained good friends during our lives, we wrote letters from time to time, and whenever I was in the USA, I visited her at her Staten Island home near New York. When she died in 1975, she kindly remembered me in her will and this allowed me to print and publish the first anthology of my Editorials *Interdisciplinary Thoughts I* in 1986.

I had of course other friends apart from Sue, some were my father's, others my own. They all took pity on me, something I did not like, as I was determined, now that I was fully qualified as a Ph D in chemistry, to make my own way and earn my living. The only ones who really helped were George and Marie-Thé Wassermann, refugees from Berlin who had been patients of my father's. He was the son of the well-known Berlin Banker and as such well-connected internationally.

M O R and Chaim Weizmann Title 25

One of George Wasserman's friends was a certain Dr Kind, a refugee from Hungary, who had brought to England a profound knowledge of lubricating oils and how, by the Edleanu process, to produce them of highest quality. The Process extracted impurities from the raw distillation cuts by washing them with liquid sulphur dioxide, a highly poisonous chemical. Dr Kind had raised in the City of London, perhaps with George's help, the necessary finance to construct a large plant at Old Trafford, an industrial estate to the south-west of the City of Manchester. His plant was situated on the Manchester–Liverpool Shipping canal and the green drums of high purity lubricating oil could thus be easily transported to customers, mostly the Fighting Services during World War II. He called his plant the Manchester Oil Refinery, MOR, for short.

It was there that I obtained my first job. I had several interviews with Dr Kind and a Dr Ernst Bergmann who was most interested in my Ph D thesis which had used catalytic dehydrogenation. I knew that this operation had nothing to do with the Edleanu process, but during the interviews I was not told the precise research work which I was to perform. The only clue I was given was that it was a new idea of the famous Dr Chaim Weizmann. So I was left guessing when I moved to Manchester and found good lodgings in Altringham, a pleasant suburb in the south of Manchester. I could easily commute by bus each day to M O R.

Chaim Weizmann, born in Western Russia in 1874 into an orthodox Jewish family, studied chemistry in Germany and Switzerland and finally settled in Manchester, where at the University he did organic chemical research and taught his subject with pleasure and success in the first decades of the 20th century. It was his discovery of *Clostridium acetobutylicum* which changed world history and brought fame to Weizmann. A world shortage of acetone had developed during World War I as it was an essential ingredient in the industrial production of cordite, the smokeless explosive used for big guns at sea and on land. With his newly discovered micro-organism Weizmann could ferment many starches, to produce large quantities of acetone.

When at the conclusion of the War in 1919 he was asked by Lloyd George, the ritish Prime Minister, what reward he wished to receive his answer was clear. As n ardent Zionist he wanted to establish a Jewish State in Palestine. Brought into direct contact with Mr Balfour, the then Foreign Secretary, and after lengthy examination and discussion, the famous Balfour Declaration was issued, the Charter of Zionism. When after World War II the State of Israel came into existence, Weizmann was in 1949 elected its first President. He died in 1952. I was commissioned in 1974 to write a small booklet *Chaim Weizmann* about him and the Institute in Israel bearing his name, to commemorate the centenary of his birth.

My first Job Title 26

During World War II, a world shortage had developed of suitable aviation fuel for fighter aircraft and what was needed then were large quantities of aromatic hydrocarbons. Weizmann was then again of the opinion that he could solve this shortage by a new chemical process, the catalytic cyclisation of long chain hydrocarbons. If he could make these chains form rings, they would become aromatic, like benzene or toluene. To carry out this research a small pilot plant had been built at M O R in Manchester and I was to work in it. This was the final explanation of my new job, given to me by Dr Steiner, the Israeli chemist in charge, working under Dr Bergmann and under Weizmann himself, who once came to see it and briefly talked to me.

Catalytic cracking was an old—established process in the oil refining industry, carried out at an elevated temperature by passing large gaseous molecules of raw petroleum through a reactor. There they broke down into smaller ones, which were the desired end product. But forming them into rings, as the new Weizmann process attempted, was entirely novel and no one knew which catalyst would achieve this.

The pilot plant was a little brick building, housing a small reactor, and a number of laboratory benches on which there were miniature reactors to find the best conditions of temperature and the most suitable catalysts to be tried out, before attempting them in the main reactor. I was working on one of the miniature reactors and I certainly carried out a large number of experiments to establish the optimum parameters for the main reaction. Much was learnt, but final success did not favour us. The catalysts we used were copper turnings and after each experiment they were found to be covered with a layer of carbon, which then had to be burned off, forming carbon dioxide.

I worked at the pilot plant for about 3 years, from summer 1941 on, and gradually became more and more frustrated as experiment after experiment failed under the specified conditions. Dr Ernst David Bergman was at the time I met him, lecturer in Organic Chemistry at the Hebrew University in Jerusalem and later the Director of the Daniel Sieff Research Institute in Rehovot. Above all he was the devoted handmaiden of Chaim Weizmann until a bitter strife broke their relationship and Bergmann switched his allegiance in the late 1940 to Ben Gurion, then Israel's Prime Minister. It was Bergman's scientific vision that Israel needed an atomic bomb for its ultimate defence and he could persuade Ben Gurion to share this view. Bergman then had a meteoric rise in Defence Bureaucracy as Head of Science in the Israeli Defence Forces in August 1948 and by 1952 he was the first Chairman of the Israeli Atomic Energy Commission. In the atomic triumvirate which succeeded in building the bomb at Dimona in the underground atomic reactor in the Negev Desert, Ben Gurion was the political master, Bergman the scientist and Shimon Peres the astute diplomat who was able to procure the essential uranium from France and the heavy water from Norway. All this I only learnt 60 years later, when Manchester's MOR had become a dim memory, but Avner Cohen's book *Israel and the Bomb* (Columbia University Press 1998) revealed it all. [See also Title 100]

See Watercolour Title 26, inside Back Cover

Back in London, it was essential to find a flat and a job. I was lucky with the flat, but unlucky with the job, at least at first. I had kept in touch with friends from Internment and one of them, Hans-Peter Binswanger, who had been a member of the Cambridge Group in Canada, was also looking for a flat and thus we combined our efforts and decided to share Number 7 Park Road, Basement, which was offered to us at a very reasonable rental. We lived there for a few years from 1942 on. Park Road begins where Baker Street ends in the North, opposite Regents Park. Mythology has it that 222 Baker Street, the home of Sherlock Holmes, was near that corner, although such a number never existed in reality.

To find a new job in wartime London was relatively easy as the Government had by 1942 set up a Central Register for Scientists to whom employers and job-seekers alike could apply, in fact a 'Marriage Agency'. I was advised by them to apply to a Paint Factory in South London who were looking for a works chemist of some experience. Was I not the right person, having worked in an oil refinery? Oils and paints were then both organic chemical liquids, both had been much improved by advanced chemical knowledge and both were essential war materials.

I was much surprised when I reached the 'works' after a trip of about 45 minutes in the Underground, the Tube. It was a large park, not really a factory, and in the park there were a number of different houses in which the paints were made. I was astounded by this arrangement but at first thought it might be a great advantage in wartime as any bomb hit would only destroy one small part of the whole. One of these houses was 'the laboratory' in which the young 'chemist-in-charge' was composing various hues of colour for the paints required. I had to learn his technique, with a large spatula, to rub pigments together with different oily liquids, which were cooked linseed oil. It was certainly a change from the MOR Pilot Plant.

The linseed oil was cooked in large conical metal containers heated by gas, the temperature control being carried out by an old workman, who had done this job 'by experience for many years', so I was informed. When I questioned the accuracy and suggested automatic temperature control by thermometers and sensors, and when my idea was put to the works manager, I was sacked. "This is not our way of doing things" and so I left after three months and a few weekly envelopes with my wages. I went back to the Central Register to try my luck again.

I had returned from Manchester to London in the spring of 1943, and after a few months at the South London Paint factory, I had obtained an excellent job [see below] in the autumn of that year. It became obvious that I should do more for the War Effort. Being in a 'reserved occupation' as a research chemist, I was ineligible for the Armed Services, quite apart from the fact that by then I had lost my German nationality, was stateless and as yet unable to become a naturalised British Subject during the War.

With continuing air raids on London, the Civil Defence Services had become highly efficient, and these were open to any citizen of good standing, without regard to nationality. The choice lay between becoming a Warden in the Air Raid Precaution Service and the Auxiliary Fire Service, the A F S. As all fires are chemical events of lesser or greater impact on their surroundings, I chose the AFS. I was accepted and issued with a thick woollen uniform and attached to Station 34 A 2 X, a converted Shell Garage in Pavilion Road at Sloane Square in Chelsea, which had a vacancy. It was apparently the nearest to Baker Street.

The Station consisted of two floors, the ground floor being occupied by the 'Appliances' and a small office, whereas the floor above had rudimentary sleeping facilities for the firemen on duty, but not fighting any fires. An Auxiliary Fire Woman was always on duty in the office, receiving telephone calls from fires and after consultation with the officer-in-charge, would ring the bells for action.

On that signal all firemen on duty would jump up, having slept if possible in their clothes and boots, would race down the narrow steps, jump onto their appliance, start the engines, and with a bell ringing loudly, would emerge into the quiet narrow Pavilion Road. After that, it was up to the Leading Fireman,—a rank I achieved after some months of service—and of course the driver, to find in the blacked-out London streets the address of the fire to which we had been ordered. This was often an exceedingly difficult task.

Once arrived at the correct site of the fire, the leading fireman reported to the officer-in-charge and was told from which angle or direction to fight the fire with his crew of three or four firemen. The hoses were then run out, the pump on a trailer behind the appliance was coupled to a nearby hydrant, and the real hard work started. Two men are essential to point a hose steadily in a given direction, as the high water pressure in the nozzle tended to move unpredictably owing to the reaction of the water jet hitting any solid object. Water spray was also inevitable and the woollen uniform soon became soaked and in winter exceedingly cold and uncomfortable.

Fires varied. There were small ones caused by incendiary bombs which would set a roof alight and could be brought under control by one or two fire appliances. Bigger ones needed more, and then the regular big fire engines were called out, if they were available. At the beginning of the War, for us in the Auxiliary Fire Service, ordinary London taxis had been requisitioned and a small pump on a trailer was hitched by rope onto the back of the taxi. There were still one or two of these at 34 A 2X and I had on several occasions the duty of driving one. It was practically impossible to reverse, as the rope did not make any solid contact between the two vehicles. Later, proper covered vehicles became available, large enough to allow for storage of hoses, seats for the firemen and the miscellaneous gear that was essential such as hook-ladders to scale buildings on the outside.

I remember one night when many fires had been notified to our station, and I was ordered to one in the Notting Hill Gate area. By the Serpentine Bridge in Hyde Park, there still exists, even today, a small Georgian House, then an ammunition store for the nearby Guards' Brigade on duty at Buckingham Palace. When I drove past it on that night, I saw it was on fire and an Army sergeant, standing outside it, ordered me to stop and fight the fire. Rightly, it was absolutely forbidden to attend to any other fire than the one to which one had been assigned, and of course I was glad not to obey the sergeant's order—a fire of an ammunition store was not exactly my favourite duty.

The 8th of September 1944 was to become a historic day. It was a warm Sunday morning and I was on weekend duty at 34A2X, when, to our great surprise, the bells were rung at the station. There was no air raid in progress and no air-raid warning siren had been sounded. Our appliances were ordered to the Guards Barracks next to Buckingham Palace, about one kilometer from Sloane Square. We soon saw that a major 'incident' had occurred, as many ambulances and other fire engines had already arrived. We were told that the first of the expected rockets, a V2 or A4, had been fired at London, and had impacted on the Chapel belonging to the Guards Regiments.

We were ordered to relieve others who had worked for hours with pneumatic road drills to break up the thick concrete roof of the Chapel. It had collapsed on the full Sunday congregation, and when I had cleared a hole with my drill, I found only the corpses of men and women below, laboriously to be extracted. A heavy road drill is not easily handled by an unskilled operator, and when it slipped through a hole, it continued to drill into the bodies below. This was certainly my worst war time experience.

I was certainly more fortunate when I went again to the Central Register to seek a new job after my brief experience of making paints in South London. They suggested that I contact the Managing Director of a firm called 'Milton Antiseptic'. "No, they are not in South London, but on the contrary in North London" I was told at the Registry. I had of course never heard of them.

When I telephoned the Managing Director, Mr Edgware, he suggested a smart restaurant for a first meeting. I think we liked each other from the first, and I was offered the position of Chief Chemist at what was then the very good salary of £750 a year. But before accepting I was anxious to know what on earth was Milton? "It is an electrolytically prepared sodium hypochlorite solution which remains stable if kept in a dark brown bottle." Mr Edgware told me. Later I learnt more about this mysterious chemical, $NaOCl$.

In France *Eau de Javelle*, a solution of calcium hypochlorite, had been known for centuries for its bleaching properties in the rural areas. During World War I, an enterprising surgeon had used a dilute solution of it for cleaning up some of the terrific, highly infected gangrenous war wounds, and he noted that they had healed cleanly and quickly. The tale, which I was told, continued with a bright English chemist who had heard of the French surgeon's success, and he prepared a solution of sodium hypochlorite, but it proved very unstable—he called it 'Shakespeare's Solution'. Another chemist soon found that the instability was due to impurities and when he prepared sodium hypochlorite by electrolysis of a sodium chloride solution and kept it away from light, he had found the stable answer and he called it 'Milton'. In 1916 production began. His name has not gone down in history.

Chemically, Milton is a solution of 1% sodium hypochlorite and 16.5% sodium chloride, which is pure common salt. In its industrial production great attention is paid to absolute purity of the chloride to be electrolysed, to the bottles into which it is filled, all being carried out at a low level of light. It has amazing antiseptic properties, chemically destroying bacteria, viruses and all other disease-causing organisms composed of proteins, without any harm to the affected tissues. The sodium chloride solution of 16.5% is isotonic and has in fact the same salt concentration as the natural body fluids.

These few facts I learnt from my elderly predecessor who retired in 1944, and he instructed me in my simple duties, namely to supervise the cleanliness of the product on which its reputation was based. However, Mr Edgware had far more ambitious plans for the Company and me, as I soon was to learn.

In 1944, with World War II still far from ending, Mr Edgware was far-sighted enough to realise that the end of the hypochlorite story had not yet been fully told. He decided to diversify into the agricultural field with the cheap calcium hypochlorite, to increase the range of antiseptic products by a high quality toothpaste, and most importantly, to set up a research laboratory to elucidate the biochemistry of sodium and calcium hypochlorites.

I was of course delighted to become the Director of Research of the new laboratory. The routine titrations of salt and hypochlorite solutions had for a long time become a dull, but essential, task and I needed a good young analytical chemist for these. I was lucky in finding an excellent one, Phil Lincoln, who as a Seventh Day Adventist could not work on Saturdays and had therefore lost his position in a Government Laboratory. Phil was also delighted to be given the challenge of compounding a good toothpaste, and thus I was free to devote myself entirely to the new research laboratory.

The Milton factory was in old crammed buildings, perhaps the original Brewery, after which the street was named, almost opposite a notorious prison. In order to expand into the medical field, Mr Edgware rightly decided that the new laboratory should be in the doctors' district, the Harley and Wimpole Street area. Suitable premises in 42 Weymouth Street could be acquired, and now the fun started for me of finding an expert staff and purchasing the necessary equipment, by no means an easy assignment in the middle of World War II.

A great help at this stage was Surgeon Commander John Bunyan, the direct descendent of the famous 17th century English writer and preacher, the author of *The Pilgrims Progress* (1678). The 20th century John Bunyan was a dentist who during his practice had found that irrigation with a dilute solution of Milton accelerated healing after a tooth extraction, cured gingivitis and was generally beneficial to all infections caused by bacteria in the mouth.

He argued brilliantly that if similar dilute irrigations could be applied to infected human skin and tissues, the same rapid healing might be achieved. But how was a liquid to be applied to the terrible burns which had been suffered by fighter pilots in the war? Conventional treatment had rarely been successful. The answer came from a Mr Stannard, a manufacturer of oil silk, who prepared suitable bags for infected arms and legs, through which the Milton irrigation could be effected. The successes were as astounding as those he had achieved in his patients' mouths, and the 'Bunyan—Stannard Bags' were soon considered as 'Miracle Bags' by patients and doctors alike. Their wide-spread use raised the reputation of Milton greatly and I had only to mention them to obtain priority, when hiring staff or buying equipment.

Whereas it was easy to explain why the Bags were so efficient in promoting the healing process, to find the scientific reasons for their success, would require much biochemical research. Contrary to all previous treatment of burn wounds, which covered the affected areas with chemical ointments and immobilised the respective limb, particularly the hands and fingers, the Bags allowed free movements, while enclosed in a sterile envelope. As the oil silk was semi-transparent, the progress of healing could be watched. The irrigation could be automatic for a few hours.

It was not the only research problem that awaited solution. It had been known for some time, but by observation only, that if any burn of the human skin was immediately treated with undiluted Milton, no blister of the skin would form, and healing was again quick and clean. This empirical fact was never published as it was rightly felt that the biochemical basis for it should be known first. I have often used this first-aid myself, found it highly effective and recommended it to friends.

My first appointment for the new laboratory was a bacteriologist and again I was grateful to find Mr Wolf who previously had worked at Reading University. He was of course full of up-to-date knowledge how a modern bacteriological laboratory should be equipped, an autoclave for sterilisation, numerous Petri dishes and an incubator in which bacteria could be grown at any desired temperature. These were obtained, as well as an assistant, to reign over the large range of clean glassware and to keep it sterile.

For biochemistry I had a colleague, Malcolm Manifold, who at that time was still studying medicine, partly at Oxford, partly doing practical work at Guys Hospital in London. He was extremely gifted and full of good ideas, not all of which could be used in practice. He acted as a junior consultant, while the senior consultant for biochemistry was Professor Gibson also of Guys Hospital. The practical laboratory work, following joint decisions by the two consultants and myself, was carried out by a junior but highly competent scientist.

A considerable investment had been made by the Milton Company and all was ready to engage in a few years of basic research. Most unfortunately the death of Mr Edgware occurred at this time, 1947, and Mr Berry of Deosan, was appointed as his successor by the owner, Mr Clough of Yorkshire. He came from the old school who believed that "Where there is muck, there is money" and he found in Mr Berry just the right commercial man to share his views. To both of them the research Laboratory contained no 'muck' and could therefore not generate any money. It was closed, I gave my notice and left.

Soon after David Martin became the Executive Secretary of the Royal Society in 1947, [See Title 61] he conceived the idea of a Conference devoted to 'Scientific Information'. This took place during the summer of the following year at the Royal Society's 'Apartments' (as they were called) in Burlington House. "It was my first big task and enabled me really to know my staff at the Society"he told me later. It was a large Conference to which scientists came from Europe, the USA and the Commonwealth. [See Title 78]

At that time, 1947, I was working at BIOS [Title 34] and was often confronted with the question "Who is the best expert on this or that subject?" Only laboriously and often after much research, could I find an answer. How useful, I thought, if there were a 'Subject Index of Scientists', which could mechanically, or now electronically, sort through thousands of records and give an easy answer, suggesting a few names, their subject and of course their address.

The Scientific Information Conference provided me with an ideal platform to launch such an Index and I proceeded to write a Paper on the subject which I submitted to the Conference and which was duly published in 1948, as Paper Number 12 in the Report of the Conference by the Royal Society. It must be remembered that in 1947 electronic computers were still only a dream for most and the one or two existing ones were in secret military establishments.

Existing books of reference about scientific information I found inadequate for my purpose. My task then fell into two parts, collecting information about scientists, and secondly, searching this information efficiently for the required answers. I drew up a Specimen Questionnaire of which I suggested 30000 should be printed and distributed.

The answers to the questionnaire were to be coded and punched into Hollerith cards, and I worked out the relevant codes for general and special subjects of research of each scientist, using for this purpose the UDC system of library classification. The cards were to be stored alphabetically by name of the scientists, and passed through a collator to locate the subjects of research or any other required information. I calculated that 28000 cards could be sorted in one hour, and as the Index would in the first instance only include British scientists, an answer could be obtained in about one hour. As the cards could be mechanically duplicated, copies of the Index could be distributed throughout the Commonwealth in an exchange arrangement.

It all sounds so simple, but I admit the difficulties speak for themselves. No wonder I never heard of anyone to this day who tried to make such an Index, even electronically.

Title 34

Col. Derek Ezra, later Lord Ezra Chairman of Britain's National Coal Board, photographed in 1971 on one of his regular underground inspections at the coal face of the Lea Hall Colliery. Derek Ezra was an old friend of student days and when in 1947, I worked for British Intelligence and visited Germany in British Army uniform, Colonel Ezra was my Commanding Officer of BIOS, and I was responsible to him. Derek had liberal policies in all his many endeavours which included the precursors to the European Union. *Courtesy National Coal Board, London Press Office.*

My next professional appointment did not come from the Central Register but by 'knowing the right people'. By 1947 the aftermath of World War II had reached a stage where it had been decided, at least in England and the USA, to find out what lessons could be learnt from the War. For example, how effective had been the bombing of Germany in bringing about a rapid end of the War? To answer this question an official Government Committee had been established under the chairmanship of Colonel Derek Ezra, later Lord Ezra.

Even before the end of the War, an even weightier question was posed, namely what scientific and technical progress had been achieved in Germany since 1933, when Hitler became the Führer, and to find out what had not been published and had remained secret. It has been called 'Reparation by Technology Transfer'. In practice, small teams of British and American experts were sent to Germany to suspect places, mostly industrial factories, but also to individuals, who had worked in fields equivalent to their own knowledge. A large organisation soon grew up, in Britain the 'British Intelligence Objectives Subcommittee', BIOS, and in the USA the 'Combined Objectives Sub-Committee', CIOS. These two were Subcommittees of SHAEF, the Supreme Headquarters of the Allied Expeditionary Forces under the command of General Eisenhower. They had therefore all essential priorities for their work.

Colonel Ezra was appointed in charge of BIOS and on his staff were my old friends, Geoffrey Brigstocke and the brothers Rupert and Walter Blum. When they heard that I was looking for a job, they introduced me to Ezra and he immediately engaged me as Head of the Research Section of BIOS. By 1947, the number of reports made by the returning expert teams had grown into the thousands, both BIOS and CIOS, and it became an urgent necessity to start a new series of 'Overall Reports' to review and summarise them in order to evaluate the lessons which had been learnt from Germany. These Overall Reports were my responsibility, in fact it was a very large editing and review job. It was invaluable training for my editorship of the two Journals *Discovery* and *Interdisciplinary Science Reviews.*

I could not carry out this assignment alone, but had to find another set of experts, able to summarise the reports of the teams, written by those who had actually visited Germany. A total of 35 Overall Reports were written and published officially by His Majesty's Stationery Office, covering many fields. They were favourably received and often reviewed in the scientific and technical literature. Again I had a very able assistant, a Mr C., formerly of Military Intelligence. I myself was able to visit Germany again in 1946 and found Berlin an utterly devastated and depressing city.

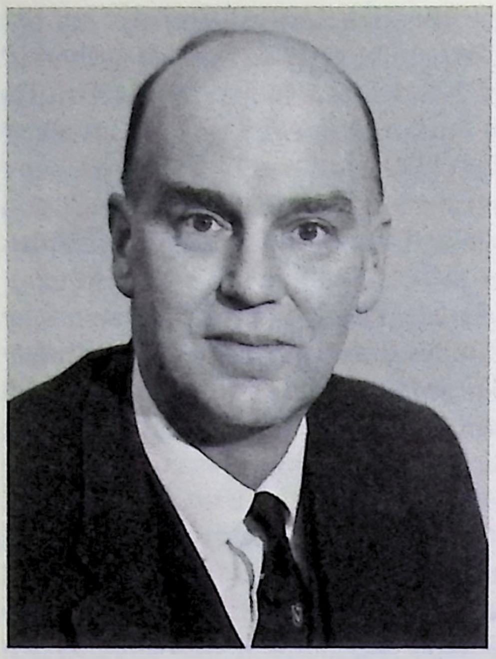
London life was not only work and finding new jobs since my return from my internment in Canada. I have already given a report about my Fire Service activities during the War for which I was awarded the Civil Defence Medal by the British Government after the end of the War. Equally important for me was the involvement with Scientific Films, but about these below. [Title 38]

Here I want to tell how by chance I met new friends and how they remained life-long dear to me. Sue Donahue was a very close friend to me for the rest of her short life and through her I met Frankie Reidy. Her father, like Sue's, was an eminent Harley Street specialist, living at 148 Harley Street. Frankie was an outstanding beauty and later married Michael Powell, the famous film Director of *49th Parallel, The Red Shoes* and *Colonel Blimp.* When I told Frankie that I was going to Sheffield to finish my Ph D, she told me "You must call on Bridget Jackson at Claycross, she is a lovely woman".

This was in the summer of 1939, just before the outbreak of the war, and having written to Bridget she phoned me and told me to come over to Claycross from Sheffield by train on a Sunday Morning. At the station there she was, a formidable lady, even then, and in full ATS (Auxiliary Territorial Service) uniform. I had never seen a lady in uniform before, a uniform I should become very familiar with later, as my wife also served in the Army before we married.

Bridget was an action lady. She had come to meet me in a small van and told me that she had to collect a number of uniforms and that I was to help her. We drove round, I loaded ATS uniforms into the van, unloaded them again at other places and finally we drove to her home for lunch. Claycross Hall was a very large home indeed, overlooking numerous factories. I soon learnt that these were coal mines and steel works belonging to her family. As a chemistry student of Sheffield University her father could easily understand who and what I was, and her parents and brothers made me very welcome.

Later on, these Sunday luncheons at Claycross Hall were the one and only real pleasure while I was in Sheffield finishing my Ph D research at the University. At the outbreak of the War Bridget was mobilised, rose quickly to the rank of Brigadier General and took up headquarters in Leeds, being in charge of all ATS women soldiers in the North of England, in fact she became O.C.N.C. (Officer in Charge, Northern Command). As such she had an Adjutant, Rosamond, later the Viscountess Hanworth, and this was the beginning of another more intimate, life-long, friendship with her and David, her husband.



Title 36

Viscount Hanworth was a close friend for many years. Three weeks older than I was, he received the classical English education of a public school. At Trinity College, Cambridge he read engineering and law and achieved distinction in both, as Lt. Col. in the Royal Engineers and as Barrister (Inner Temple). In his free time he was devoted to colour photography at the highest amateur level, publishing two books. Married to Rosamund Parker in 1940, they gave me a home at their large house 'Folly Hill' in Ewhurst when I was a refugee. I spent many happy weekends there talking politics and engineering with David while helping him relaying the terrace. I helped Rosamund in other ways, and I therefore felt that I was able, to some degree, to return their generous friendship. As a liberal, David contributed greatly to the free-thinking crossbenches in the House of Lords. *Courtesy Viscountess Hanworth.*

My best Friends – The Hanworths Title 36

Rosamond was married to the Viscount Hanworth, an officer in the Sappers, the engineering branch of the British Army. He served with the British Expeditionary Force in France during the 'phony war' and was evacuated through Dunkirk in 1940. By that time Rosamond had left Northern Command and was stationed in the South of England. During the war years (1939-1945) I did not see much of either Bridget or David and Rosamond, as travel by train was extremely difficult and I was living in London.

It was only after 1953, when David and Rosamond had moved to 'Folly Hill', a lovely large house overlooking extensive rural areas near Guildford, that our friendship really began. I had a car by then, belonging to the Milton Company, and I could easily drive to Folly Hill for the weekends, indeed a great pleasure. Folly Hill was by no means in good repair, and the terrace, consisting of great flagstones, needed much attention. The heavy flagstones had to be lifted, a two-man job for David and me, a new sand base had to be levelled underneath them, and they had then to be lifted back. A real back-breaking job, which occupied me for years, during which our friendship grew and grew. I also built a wall which the Hanworths called the 'Antonine Wall' after the Roman frontier barrier, built in AD 142 north of the famous Hadrian's Wall. 'My' wall was of large sandstone blocks which I cemented together, and I hope it too will last for centuries.

David, bald at an early age, had read engineering at Cambridge and after the war served in Hong Kong, where he was in charge of building the modern water supply system for the Colony. After that he was in the British Occupation Forces stationed in Germany. Rosamond, by then demobilised, accompanied him whenever possible, and their marriage was exemplary. Three children were born, a girl called Gilla, Stephen the heir to the title which he inherited on David's death, and Charles the youngest son. I have known them from early childhood, and all three are as good friends as their parents. In fact, Rosamond appointed me an 'honorary uncle'.

Stephen, Viscount Hanworth after David's death and until the Labour Government abolished hereditary titles in 1999, now Stephen Pollock, as bald as his father, is a brilliant mathematician at Queen Mary's College, part of London University. There he has achieved an international reputation, and he is often invited as a visiting professor to Austria and Poland. While at Sussex University he met Liza from Zimbabwe, a coloured student, and their marriage is as good as that of David and Rosamond's was. Liza had a most difficult job as a headmistress of a school in the East End of London with rough and even violent pupils and their difficult parents.

David Hanworth was an engineer, whose knowledge and imagination never helped him to achieve the high position in industry for which he was qualified. He showed his real skill in his hobby, motor cars, particularly Jaguar models. In industry, and he worked for several companies including De Havilland, his great handicap was his lack of interest for the commercial aspects of engineering. During the many weekends when I enjoyed his company at Folly Hill, my most vivid memory is to see him working on his Jaguar, whichever model he owned at the time. He was able to rebuild complete sections of the body and even of the engine, if he considered this essential to the good looks and performance of his car. Later he spoke often in the House of Lords, but always from the 'Cross Benches', occupied by those who were neither Conservative nor Labour party member. I admired him greatly, not only for his political views which I shared.

When the children were grown up and married, Folly Hill became too large and David and Rosamond moved to a smaller house nearer to Guildford. It was then easier for him to catch a train to London to attend the sittings of the House of Lords, where he spoke about energy, education and the need for parliamentary reform in England. Politically, David was independent, and could thus say what he considered to be right and did not come under the supervision of either party boss, the so-called 'Whips'. David particularly deprecated the growth of 'adversarial politics.'

His liberal attitude taught me much and he continued what my father and Mr Oldershaw, my former tutor, had already shown me to be the right attitude to politics. In addition, Rosamond's warmth, humour and wisdom made their home a centre for all the growing family and for their many friends among which I was lucky enough to count myself. I was often lonely, and whenever I had a new girl friend, I asked, and was never refused, to bring her down to Folly Hill. Rosamond was invariably warm and hospitable, and I only learnt later if she thought any of them rather 'unsuitable', as she put it. My daughter Bar and her husband, Geoffrey Wells, were made equally welcome on their one, rare visit from Australia to England

As it is not unusual for Members of the House of Lords and their wives to be invited to go to foreign countries, David and Rosamond went on one such visit to the Turkish part of Cyprus. Rosamond, by then a respected and highly qualified archaeologist, who had discovered, excavated and published about Roman antiquities in Surrey, was so impressed by Cyprus, that she decided to write a book about Cyprus antiquities for visitors to the Island. It was greatly admired and well reviewed. The close friendship of these two wonderful people will always be something for which I am deeply grateful.

It must have been around 1942, or perhaps a year later, that a few Scientists and Documentary Film Makers got together in London. and formed 'The Scientific Film Association'. Among its founding members, were Sir Arthur Elton Bart, Jack Chambers and Colin Ronan, as well as Michael Michaelis and later myself. We were clear about the SFA, as it soon was called, that its aim was to encourage the making of more scientific films. These were, by our definition, the best way of teaching science to all who were soon to be released from the Armed Forces and had to engage in new jobs—which we thought were bound to have a scientific basis.

We had a great deal of conviction and enthusiasm, as well as benevolent financial and material support from the great Documentary Film Making Units, like Shell and the Crown Film Unit, the official British Government Unit. Desks and chairs were soon borrowed, and in a corner of an office regular afternoon meetings for the various Committees of the SFA were inaugurated. The latest scientific films, which came from the cutting rooms were borrowed and screened, at first just for our own delectation. Later when the National Film Archives had agreed to include scientific films among the National Treasures to be preserved in their vaults for all eternity, these SFA screenings became the official decision making process, if a new film was to be preserved, or allowed to be forgotten. We had achieved decision-making power and the SFA was truly recognised.

Another important activity of the SFA which arose from these screenings was the preparation of many lists, according to subject or according to suitability for school classes at various levels, or for University teaching. These lists were authoritative and were widely distributed—I cannot now recall after 60 years—whether they were free or if a small fee was levied.

Once the War was over in 1945, and 'normalcy' had slowly returned, it meant that international contacts could be established again. We soon found that very similar organisations had been formed in France and Germany and later in other European countries. An International Scientific Film Association was founded with the same aims and objectives as the SFA. But the Organisations had different backgrounds and means of support. So for example, in Germany, *Das Institut für den wissenschaftlichen Film,* under the able guidance of Dr G. Wolf, was an integral part of the University of Göttingen, which had certain financial advantages and allowed the Institut to make its own films with its own cameras and other optical facilities. They were of very high quality and the Institute published its own Journal *Research Films* to which I contributed from time to time. (See Appendix II)

Title 39

Michael Michaelis is a Member of the ISR Editorial Board, as his wide managerial and industrial experience, based originally on electrical engineering research and later as Washington Manager of Arthur D. Little, gave him great interdisciplinary knowledge. Although not directly related to the Author, close friendship of over 50 years, has led us to call each other "brother". Michael was President of the Cosmos Club in 1996. *Courtesy M. M.*

SIR ARTHUR ELTON Baronet was by the time I got to know him in the middle 1940s at the height of his professional reputation as the Director of the Shell Film Unit. He was the 10th Baronet, an inherited title, and had a lovely large home, Cliveden Court in Somerset. Arthur was also a great collector, and owned a large number of books and pictures dealing with the early period of the British Industrial Revolution from 1770 on. As a maker of scientific films and later, as supervisor of others, he was superb, with the right amount of basic knowledge and artistic conception. He died in 1973.

GEOFFREY BELL was also a distinguished scientific and documentary film maker, who had studied science at Cambridge. His greatest film was *Transfer of Power* for Shell. Later he worked for the United Nations and when subsequently his thoughts turned to Buddhism he left England and settled in Bangkok. His ideas were often very unconventional, and he was a very stimulating and good friend to me. He died in Ireland in 1999.

MICHAEL MICHAELIS became my 'brother' when during my frequent visits to Mike's home in Washington DC in the early 1960s, we both were tired of explaining at many cocktail parties, that, YES, we were both scientists, YES we were both born in Berlin, YES we spelt our name the same way, NO our parents were no longer alive, YES we had lived in London and both had helped to start a Scientific Film Association there. So much easier, simply to pretend we were brothers, nobody ever exposed our adopted family ties. He is, after 50 years, still one of my closest friends and our relationship has become that of true brothers.

Michael had a distinguished career in early electronics and radar research during World War II. When later he went to the USA, he became the Manager of the Arthur D.Little office in Washington and Senior Advisor on atomic energy to President Kennedy's Special Assistant for Science and Technology. In 1998 he was elected President of the famous Cosmos Club, a very great honour for him. [See Title 306] Michael's first wife, Diana Tead from Boston, was a brilliant media communicator and was as much interested in Documentary Films as Michael was in Scientific ones. Their marriage was very happy, until it ended through her tragic death from cancer.

JACK CHAMBERS came from more humble origins than Arthur Elton, and Jack remained faithful to his communist convictions. His scientific films were of great social concern and much admired.

COLIN RONAN (1920-1994) was an astronomer, a science writer, lay preacher and lecturer, musicologist and conjurer. Jack, Colin and I joined the Founders later.

I was a member of the Sciences Committee of the SFA, and when it was suggested that a Conference should be organised on the subject of *The Film in Scientific Research* I took a great interest in this proposal and spent much time and effort in its organisation. I was fortunate and could persuade Sir Robert Watson-Watt FRS (1892-1973) to take the chair and thus got the support of other speakers for the conference. It was held at the Royal Institution, 21 Albemarle Street, London W 1, in October 1948.

Sir Robert became famous for the first practical radar system in the world which was vital for Britain's air defence in 1940, when attacked by the German Luftwaffe. He had started with his 'radiolocation' research in 1935 when he became Head of the Radio Department at the National Physical Laboratory in Teddington near London and before the outbreak of the war in 1939, he could locate planes at a distance of 110 km. No doubt great use was made of cinematography in his research to record the pictures on the cathode ray screen which showed the time delay between outgoing and returning radio pulse, and thus the distance and speed of the approaching plane.

In 1948 radar was still top-secret and Sir Robert did not even mention the subject during our conference. Most of the other speakers—I regret I cannot remember their names after 60 years—praised the value of cinematography in their respective fields of research, but all had one regret which they suggested the SFA could remedy. There was no book on this subject, except a few widely dispersed research reports in the scientific literature. The last review in English had been written by Donaldson in 1912 and a fairly popular digest by Thévenard and Tassel in French had appeared just after the conference.

It was there and then that I decided to write this review. My book was published in 1955 by Academic Press of New York, under the title "*Research Films*". I defined these as: "Research films are motion pictures made in the laboratory, or during the course of field work, which aid directly in the discovery of new knowledge. The necessary techniques for their production, analysis and usage, I have called scientific cinematography." [*Preface page ix* of my book *Research Films]*

I shall say more about the writing of this book in Australia below, [see Titles 56 to 58] but suffice it here to mention that I could quote in my combined Author and Reference Index more than 1490 entries. I received 35 highly positive reviews of the book in the scientific and cinematographic literature—it was a labour of love, but not a lost labour. I calculated that the royalties I received could not have paid for the cigarettes I smoked while writing it.

Ann Aikman Title 41

I was about 27 years old when I met Ann Aikman, then 20, and in due course we got married at Chelsea Registry Office in London on 12 November 1946. We met in the middle of the War when I was working during the day at Milton's and spent about three or four nights a week at the Fire Station near Sloane Square. At the Station there was always a telephonist on duty, also an unpaid volunteer like all firemen, but her title was of course Firewoman. It was Firewoman Elizabeth from Ilkley Moors in Yorkshire, who was for a time my best girl friend.

My best man friend during those days in the early 1940s was Christopher Forbes-Adam, later Sir Christopher (Baronet) then the Diplomatic Correspondent of the excellent *Yorkshire Post.* It was a strongly conservative newspaper which coincided with Chritopher's views, but not always with mine. Politically I did not then, and do not now, agree with any political party, simply because my views are based on a very simple concept: 'Progress through science and technology to promote the greatest benefit to the greatest number of people'. The Scientific Temper in fact. As far as I know no political party has as yet adopted my programme and has therefore not been able to enlist me as a member. [Title 145]

Now, both Christopher and Elizabeth had a common friend Sim Cooper-Willis and her parents were the legal guardians of Ann Aikman. So, when there was a great party given by the Cooper-Willis, and they were one man short for their table, I was asked and met Ann Aikman. She had just finished at Sherbourne Girls School, a very good public girl school for young ladies, and her Guardians had advised Ann to spend some time at a 'Finishing School for Young Ladies' in Pont Street, Chelsea.

During the party I danced with Ann and asked her of course what she was doing during the war and what was her contribution towards victory. I must have sounded very conceited, pompous and bombastic, but I was genuinely interested what an intelligent, young and attractive girl was contributing. Her reply 'attending a finishing school' stunned me and I remember giving Ann a lecture that she could do far more for the country, join one of the Women's Auxiliary Services, like the ATS (The Auxiliary Territorial Service) of the Army. I had in mind the work which Bridget Jackson and her Adjutant Rosamond Hanworth were doing at the time. It was a few weeks later that either Christopher or Elizabeth told me that Ann had joined the ATS and was now in uniform at a training camp not far from London. I was of course much flattered and impressed and asked Ann for a date on her next leave in London. Perhaps I cooked her a meal from dried American eggs and we soon became good friends.

Ann had not had a very happy youth. When I met her, both her parents were dead and her home, after leaving school, was the small Chelsea flat of her legal Guardians, Mr and Mr Cooper-Willis, a retired professional gentleman and his non-academic wife. Ann's father had been a doctor in the south of England of some considerable means, and as far as I could gather his wealth arose from a family connection with the Scottish publishers Blackies. Ann was due to inherit her parents fortune on her 21st birthday on 11 November 1946. As the Cooper-Willis's were of the opinion that I was only interested in Ann because of her inheritance, I was never welcomed by them and they tried unsuccessfully to prejudice Ann against me.

However, our friendship grew into mutual love, and after Ann had joined the Army, she spent her not infrequent weekend leaves with me in my flat at the top of London's famous Baker Street. We had a good time together, as far as that was possible in war time with strict food rationing and with the little money we then had between us, but we were both very happy and endlessly discussed our joint future. There was no doubt in our mind that we would get married as soon as she reached the age of 21 and became legally independent of her Guardians.

I remember that the first thing I was able to teach Ann was cooking, as in her parents' home she had never been allowed in the kitchen. Peeling potatoes was a new skill I could impart, but of course it did not stop there. I was convinced that what the world then needed was more social scientists, as the physical sciences had proved their value during the War more than adequately, even before the advent of the atomic bomb. Ann agreed with me, and we decided that after her demobilisation from the Army she would study Psychology at London University and with her excellent school record, she had no difficulty to obtain a place at London's University College's Psychology Department. This fact greatly facilitated her speedy demobilisation.

We could plan ahead for the wedding to take place on 12 November 1946, for a three-year course of study at London University and then to emigrate in about 1950 to Australia. We were worried that a Third Atomic World War would break out and we wrongly considered then that this War would be confined to the Northern Hemisphere. It was only in 1957 that Nevil Shute published his book *On the Beach,* in which he forecast how an atomic war would spread from the Northern to the Southern Hemisphere, and he described the last few months in Australia before all life had ceased on planet Earth. Had Ann and I read his book in 1947, we might never have emigrated.

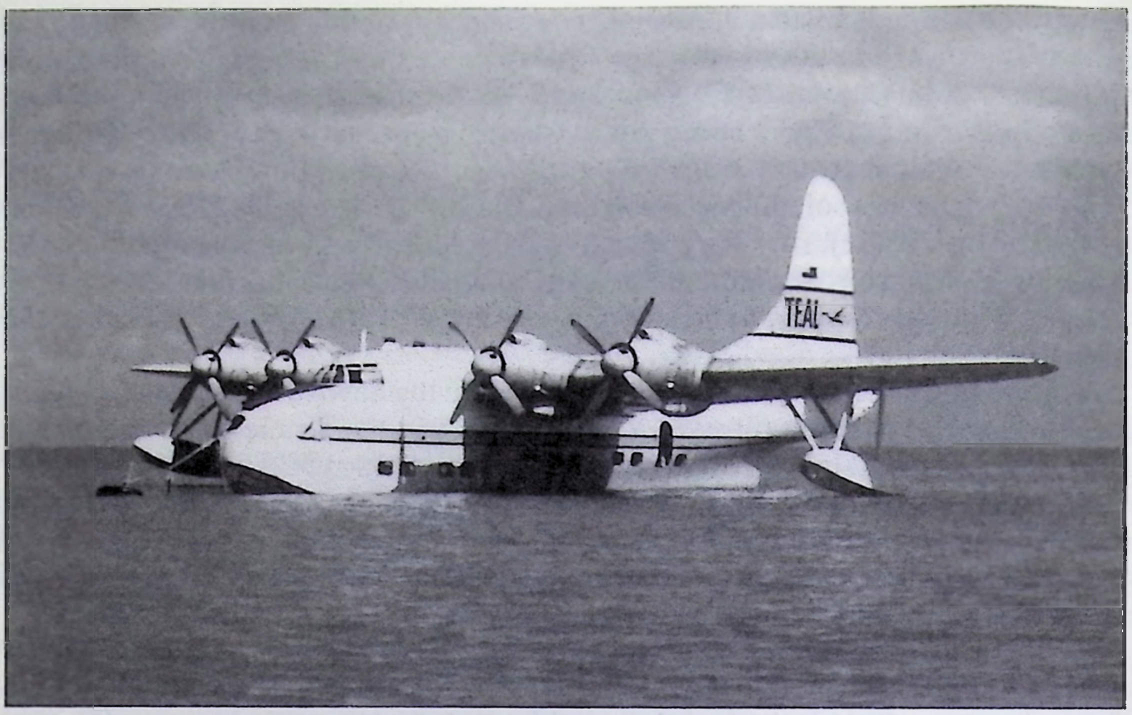
As neither Ann nor I had any parents to arrange our wedding for us, we did it ourselves. There was no question of any Church ceremonies, although we both were Christians, Ann Church of England and I was Lutheran as christened and confirmed in Berlin. As Ann's home was in Chelsea we went to the Registry Office in the Metropolitan Borough of Chelsea on the morning of 12 November 1946, where "This Marriage was solemnised between Kurt Otto Michaelis, 30, Bachelor, Scientist (Board of Trade), of 7 Park Road, St Marylebone and Ann Margaret Butler Aikman, 21, Spinster, Student, of 12 Astell House, Chelsea in the presence of us, G. Cooper Willis and Walter Wallich." So reads Entry 179 of Marriage, Pursuant to the Marriage Acts.

A small lunch followed, and then we moved to the Savoy Hotel where we had a rather magnificent room reserved with a view across the Thames for 24 hours at a price of £ 5. We had invited about 150 friends for drinks at 5.30 in the afternoon to come to the Savoy to celebrate our happiness with us. Sir Andrew McFadyean, an old friend of my father's, made a short speech and proposed our happiness. It was all very informal, very properly done and certainly gave Ann and me great pleasure to have so many good friends rejoice with us.

For the more intimate friends, we had reserved a private room, and if I remember correctly, there were 24 for dinner and for dancing afterwards. It carried on until the early hours of the morning. Ann and I retired to our lovely room, not a suite, when we were tired and went to bed. It was an ideal arrangement that our guests could continue dancing and drinking until they were tired, and everyone could suit himself or herself.

These happy events were only possible because Ann had received her inheritance on reaching the age of 21. The bill at the Savoy Hotel was her first major expenditure, and I think the total was below £ 500. It was not Ann's only major use of her new riches. She gave me as a wedding present a most magnificent car, a 1935 Lagonda, with a 4.5 litre engine, open touring body, painted silver. We called it 'Diana' and kept it in our true affection in England and then in Australia, as long as our marriage lasted.

We had a splendid holiday tour through the French Pyrenees in the early summer of 1948, when Ann was three-months pregnant with our first daughter. We saw a good French doctor in Paris before setting out on our Grand Tour and he told us that at the same stage of pregnancy he and his wife had made a similar journey through the Pyrenees. "And what became the profession of your son?" asked Ann. "Oh well"the doctor answered somewhat reluctantly "he became an excellent racing-car driver".



Title 44

The Short Brothers **'Empire Flying Boat'** which took my wife and me on our honeymoon to Australia, New Zealand and back.We enjoyed luxurious comfort and endured a few hours of acute danger over the Tasman Sea. After BOAC ended their service, some aircraft such as this one survived, for the Tasman Empire Airways Limited from 1949 to 1960. This flying boat is now in the Auckland Transport Museum. *Courtesy TEAL.*

Australian Honeymoon—First Stage to Singapore Title 44

After the wedding feast at the Savoy Hotel, Ann and I spent a day in the country in the home of Fritz and Bridget Lingen. It was just a very short break, as Ann was by then working hard at University College for her psychology degree and I had my office job as a Civil Servant at BIOS, by then taken over by the Board of Trade. We were firm in our belief to emigrate to Australia, and as we were now married and both wanted children in due course, we also thought that they would have a better future in a new country. War-time lingered on in England and rationing seemed never to end.

So we decided that we would have a proper honeymoon trip to Australia to have a look at the country. However, before doing so I wanted to become a naturalised British subject and travel to Australia on a British Passport. I swore my oath of allegiance to 'His Majesty King George the Sixth, His Heirs and Successors' on the 8th of April 1947 as Kurt Otto Adolf Michaelis, the names given me at birth. I changed my three given names to Anthony Rowland by Deed Poll later, on 25th February 1948.

To fly to Australia in 1947 was only possible by Imperial Airways in their magnificent Sunderland flying boats, starting from Poole in Dorset to Rose Bay in Sydney during a 7 day and 7 night voyage. Luxuriously comfortable, in small four-seat cabins, with meals served by uniformed stewards on white table linen, one could walk about inside the roomy observation lounge and stretch one's legs. From Poole, with a short refuelling stop in Marseille, we spent the first night in Augusta, Sicily. The second day, flying from about 8 o'clock in the morning, we landed on the Nile in Cairo at 4 o'clock in the afternoon and spent the night in the world famous Shephard Hotel.

Having met an Egyptian student Omar Pasha at Cambridge, we were able to tell him of our arrival in Cairo, and he and his wife joined us for dinner. Ann and I had spent the afternoon visiting the Pyramids and amused ourselves on a brief camel ride. The third night found us in Bahrain on the Persian Gulf, after a dull flight over limitless desert mountains. In those days the Hotel in Bahrain was rather primitive without any air-conditioning and we were glad to leave early on a very long flight to Rangoon in Burma, with short fuelling stops in Karachi and Calcutta.

Our fourth night in Rangoon allowed us a brief walk through the city before dinner and a welcome rest before the next day's shorter flight down to Singapore. There we had again all the luxury that Raffles Hotel could offer the weary European in a tropical climate, with normally a humidity of 90 % and a temperature of 90 degrees Fahrenheit, 32 °C. It lies on the Equator and thus its climate never changes.

Raffles Hotel, named after Sir Stamford Raffles (1781-1826) the founder of the port city of Singapore and administrator of the East India Company, has prided itself on its high standards and large luxurious suites. Even in more recent years, by obtaining a suitable price reduction as a Member of the Press, I was able to enjoy its luxury until I found the equally superb Tangling Club in Singapore. On our honeymoon we thought that the next stage from Singapore to Sydney would be dull and short, but not so.

We took off as usual, along a cleared lane in the busy harbour, with the spray on the flying boat's hull rapidly diminishing, until we rose high enough to have a look at the harbour and the city we had left and where we had spent our fifth night. Our stop for the sixth night was scheduled at Surabaya on the Indonesian Island of Jakarta, and when we landed there, we found ourselves in the middle of its War of Independence from the Dutch Colonial Administration. We were not allowed to leave the precincts of the hotel, but the magnificent *Rice-tafel,* consisting of countless small dishes, each more delicious than the next, made up for the military confinement.

One more day, across the featureless but shark-infested Timor Sea to Darwin on the north coast of Australia, and there the last scheduled night-stop on our flight, at least so we thought. When we arrived in Darwin we were told that there was a strike at the Rose Bay Terminal of Sydney Harbour, the end of our flight, and that therefore the flying boat could not proceed. Instead we were to continue on a Dakota DC-3 land plane, which would first take us to Daily Waters for the night and then on to Sydney the next day.

Now Daily Waters consisted of a war time flying strip and a local pub, and is somewhere in West Queensland, or the eastern part of the Northern Territory. I cannot find it on *THE TIMES World Atlas.* Probably the landing strip is no longer needed and perhaps the pub has gone bust, there being no more customers around. But in 1947, Daily Waters was teaming with people who had come from hundreds of miles around. It was the one day of the Circus, which visits once every three years, and so Ann and I had a first night in Australia to remember. The pub had been booked out months ago, and we slept on the floor of the veranda, if indeed we slept at all. Of course we saw the circus, of course we drank a glass or two of beer, but beyond that I doubt if any one could remember more of that remarkable night in Daily Waters that once was on the map.

The last hop to Sydney was uneventful, and we arrived rather tired and were glad that once again the comfort of a good hotel, the Wentworth, received us.

Australian Honeymoon—Near Disaster and back Title 46

There is not very much to tell about Australia during the time we actually spent there as pure tourists. The real result was that we liked the country and the people, the climate and the free and easy style of living. It was 1947 when we visited, and the War had also touched Australia deeply; the treatment of the Australian prisoners of war by the Japanese in their terrible camps was often discussed. The hate of everything Japanese we found, was just as deep, as I had hated everything connected with Germany.

Although there was no rationing of any food, there was a remarkable lack of imagination in the meals we had in the hotels and restaurants. Magnificent steaks were served, but either 'Steak and chips' or 'Steak and eggs', and with it there was either Tea or endless 'Schooners' of beer as the small glasses were called. We travelled to Melbourne, but found it too much like England, conventional and rainy, and we even had a look at Adelaide. This we considered too small and provincial, and our choice fell on Sydney which we never regretted.

While in the Southern Hemisphere we also wanted to have a look at New Zealand and this ended nearly in disaster. We took off from Sydney's Rose Bay in a Flying Boat, a pure routine for us, and expected a 10 hour flight. But as there was no meteorological forecasting in those days, the pilot found himself halfway across the Tasman Sea facing a tropical cyclone. He tried to fly over it, but could not, he tried to fly under it, but could not. The only, the last, alternative, was to return to Sydney, but had he passed 'the point of no return'? He certainly did not tell us.

The passengers' mood was by now pretty desperate, many had been airsick, and one of the Stewardesses, Joy, was being run off her feet. I was able to help her and this led to a life-long friendship, extending into the generation of our children. When the flying boat neared Sydney again we realised how near we had been to disaster, as it barely could fly over the roofs of the houses before landing. We eagerly bought the newspapers with their headlines "Destroyers left to pick up survivors of flying boat disaster". Indeed, we had a near miss!

But not as bad as for others, including a Bishop, who were flying the same route a few weeks later, when the pilot, faced with the same situation, decided to dump all luggage into the sea to save his flying boat. (We read about this event in *The Times* when back in London.)

We left Rose Bay again the next day, with fewer passengers and more fuel and reached Auckland, spent a fortnight touring, but found the country too agricultural for our liking. Sydney was our choice, and so back to London by flying boat, along the same route with the same stopovers, equally pleasant.

Getting ready for Emigration Title 47

Once we had decided to live in Australia, we gave ourselves three years for the preparations and set the date for the spring of 1950. Much had to happen. Ann wanted to get her Bachelor of Science degree in psychology and I had decided to make research films in Sydney. Then, of course, the major family event was the birth of our first daughter, Frances Barbara, on 19 December 1948 in the London Hospital. in Whitechapel. Why that far distant Hospital was chosen, I can no longer remember, but I do know that I drove Ann in the open Lagonda there and fetched both her and the baby back in it. We had prepared the small flat in 7 Park Road for the great event and all went smoothly.

As Ann had to attend lectures and do some practical work at University College, we had to find a Nanny to look after Bar, as we, in the family, have always called our first daughter. Nanny proved a tremendous success and came with us to Australia where she continued as a real family member until her death many years later. The picture I shall always remember from those last years in London, is of Ann breast-feeding Bar and in her other hand holding a psychology textbook which she was reading. What a marvellous woman I had married, and I was deeply in love with her. I was very proud of her.

My knowledge of making research films had so far been purely theoretical, and if I was going to make them in Australia I had to acquire cameras and other specialised gear for high speed cinematography and for time-lapse recording. To learn these techniques I was lucky in having good friends at a small company, SIMPL, (Scientific, Industrial, Medical Photographic Laboratory) in Lambeth, opposite the Archbishop's Palace. The senior director, who had put up the capital was Robin McVittie Weston, expert in cinemicrography and Derek Stewart whose skill and knowledge of high-speed cinematography, up to 5000 frames per second, was unique in England at the time.

Robin had been a solicitor for most of his life, but a keen amateur microscopist and collector of microscopes. I do not know now who persuaded him to found SIMPL, it might well have been Derek Stewart, a very good salesman and a persuader with remarkable charm. Derek had worked for Kodak in London for many years and when Kodak brought out their American High Speed Camera to England, he got the job of selling it and its applications. These two experts welcomed me at SIMPL and I had a hectic apprenticeship there, quite apart from my being a civil servant at BIOS.

Ann was generous as ever and gave me the money to purchase cameras, tripods, research microscope, powerful lights and a great deal more for my future film activities in Australia. So all got ready for the great trip with baby Bar and Nanny.

Sea Voyage to Sydney Title 48

On Wednesday 5 April 1950, at 10.30 in the morning, it was quite a party that left London Euston Railway Station for Liverpool: Ann, Baby Bar, Nanny and myself. The day before I had weighed the family, Bar was 24 pounds, Ann 118 and myself at 220 pounds, 99.6 kg. (I had again started a Diary and kept some records)

We left Liverpool on board the *SS Helena,* Blue Funnel Lines, on Good Friday, at 00.12 hours, 7 April 1950. She was a Cargo Steamer with accommodation for six passengers and she was very comfortable for the few who took passage on her. I kept a record of the daily position at noon and on an average we sailed about 450 miles every 24 hours. We arrived at Port Said 7 days out from England and on 18 April at Aden where we fuelled, it being the cheapest supply on the route. After that, we saw no land again until we arrived at Williamstown—Melbourne on 3 May, after 25 days, 13 hours and 11 minutes out from Liverpool. It was a thoroughly pleasant and comfortable voyage, with a maximum temperature of 31°C, one day out of Aden in the Red Sea.

The advantage of the cargo steamer was a break of 10 days at Melbourne, where we visited friends, before the last one-day run to Sydney which we reached on 26 May in a tropical rainstorm. We proceeded to a rented Bungalow in Beecroft, a pleasant Northern Suburb. The Lagonda car was not unloaded until a week later, with 72736 miles on her speedometer clock.

Settling in at Beecroft, about 30 km west of Sydney's Centre, was again a major job for all. Our good friend John Heyer, who had a major share in persuading us to emigrate to Australia, lived nearby and gave us tremendous assistance during the first days and weeks. He was then Director of the Shell Australia Film Unit, and three weeks after arrival I left with him in his 1948 Chevrolet for a journey to Queensland to film one of Shell's drilling projects at the Morella S+D Camp. It was a four-day car journey and on the last day before reaching Camp, we were stuck in a bog for 8 hours overnight.

It was certainly a staggering introduction for me, to see the small towns we passed on our way, the tropical forest in which the camp was located and the return when flooded rivers stopped our progress home. I also learnt the local safety procedure to make the passenger walk in front of the car when driving through a flooded part of the road—if the water did not reach above his knees, the car would follow, but if the passenger was drowned, well, the car would not follow! This did not happen to me, but I quickly learnt the Outback way of behaviour in Australia. At one stage, Ann was even going to send us food parcels from Sydney, when we were cut off for a day or so. I could not have had a better introduction to the real Australia!

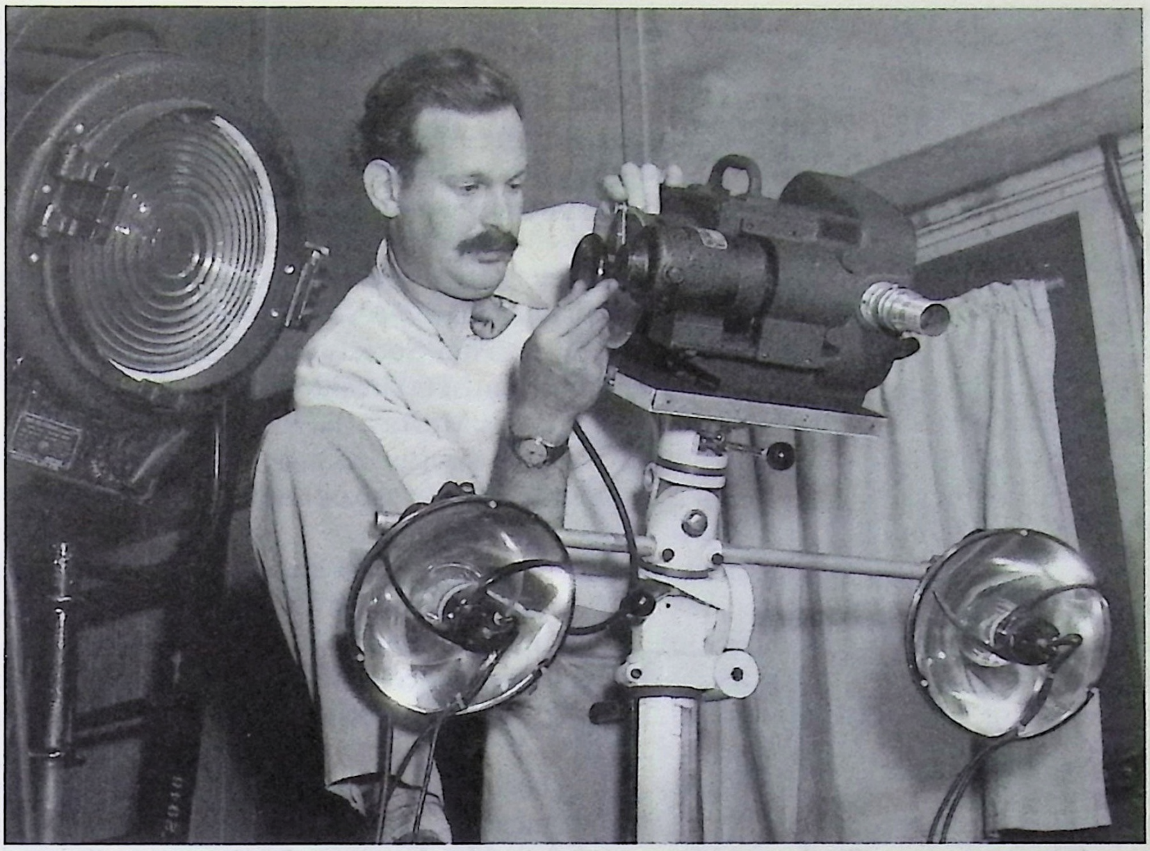
The rented bungalow in Beecroft was for us only a very temporary affair. Our first priority was to find a house, large enough, not too expensive, not too far away from the centre, new if possible, and in pleasant surroundings. We drove to estate agents far and wide, to all possible areas, and invariably the agents made suggestions of houses, they thought 'perfect' for our requirements. Ann and I learnt quickly to discriminate right from the agent's first words, and I started a card index of each house we saw. When we exchanged contracts for our 'right' house on 29 September 1950, it had taken us only four months to find it, and I could sell my index of 50 houses!

The address was 14 Sirius Avenue, Mosman, an old suburb on the North Shore of Sydney's world-famous harbour, and our 'perfect' house was separated from the Harbour itself only by a Nature Reservation of a belt of trees and wild growing castor-oil bushes. Nobody could ever build in front of us and spoil the view. It was brand-new, had no garden as yet, no air-conditioning (practically unknown then), but had central heating (quite essential for the damp and cool winters). One old eucalypt tree had been kindly left by the builders and I started to plant trees, as fast as possible, a veritable *Arboretum*. I remember that on a trip to Canberra, I pulled out of the ground a small poplar seedling and planted it at home. It grew 3 meters in the first year but had to be removed as its roots threatened the foundations of the house.

We were equally unlucky with a mulberry tree, whose red fruits spoilt the lawn, but lucky with banana seedlings near the kitchen which multiplied and bore many fruit from their, at first red and quite obscene-looking, bunch. There is another unlucky tree story connected with our house. On 30 May 1953, a day of double celebrations, the day it was announced that Mount Everest had been climbed for the first time by Hillary and Tenzing, and also the official birthday of Queen Elizabeth II. On that day I decided to use this holiday to cut down the old eucalypt tree.

It stood right in front of our terrace, and I secured it with a strong rope from falling into the street below. But the rope was not strong enough, it fell across the overhead electricity supply wires, cutting them with a beautiful display of sparks and depriving the district of electrical power. You should have heard the exclamations of "bloody pom" from the neighbours when they found out that I had been the cause of the local disaster. ('Pom' or 'Pommy', is the favourite Australian swearword for an Englishman, supposed to originate from his rosy cheeks, resembling a pomegranate).

We even hired a sheep to keep down the grass, but it preferred the flowers!



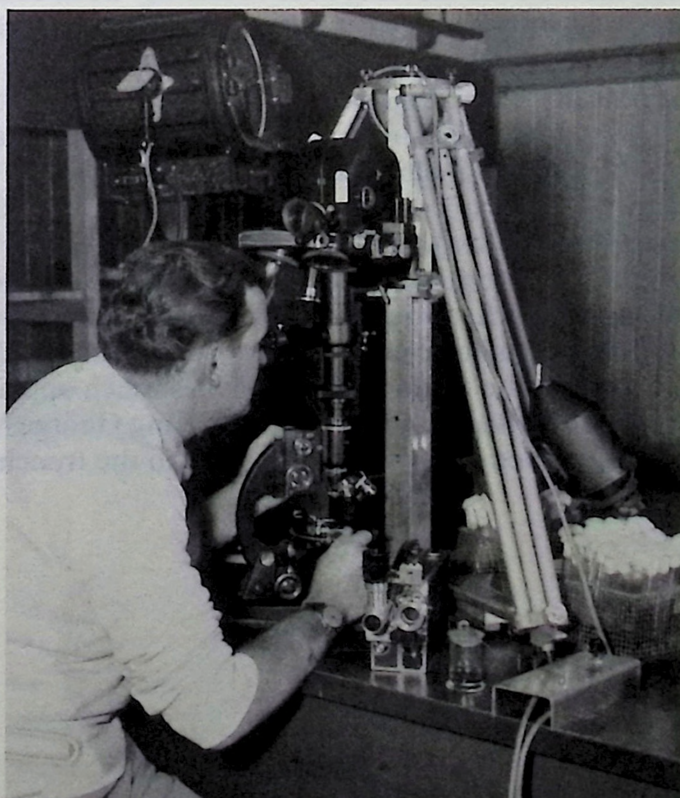
Title 50

I was fortunate to have a room at the **University of Sydney** for my cinematographic research equipment and an influential friend, Tony Whitlock, on the staff of the *Sydney Morning Herald* to have these photographs taken and published in 1950.

Horizontal The author adjusting his Kodak High Speed Camera.

Vertical To take moving pictures through a microscope, each cinemicrographer has to design and build his own unit of camera, microscope and beam-splitter, so that he can see what he is filming as the author is doing.

Courtesy Sydney Morning Herald.



We had indeed found our ideal house. By Lagonda, over the Sydney Harbour Bridge, it took about 30 to 40 minutes to the University of Sydney, where both Ann and I were going to work. She had found a thriving Department of Psychology with a really delightful Professor, Bill O'Neil, who enrolled her as a Ph D student. I found a room in the Department of Aeronautical Engineering, where I could set up my cameras and offer my services to anyone at the University who desired to use them for making research films.

Any new product needs advertising. Scientific, let alone research, films were quite unknown at Sydney University. So, I decided the best way would be to start a Scientific Film Society, the Sydney Scientific Film Society, SSFS, as it was soon called. The first step was to find an eminent scientist as President of the new Society, and I was very lucky to persuade Professor P.D.F. Murray, the Professor of Zoology, to act as the President. I could not have found a better person, combining charm, knowledge and skill in pacifying the sometimes different opinions of the Society's Council members.

A Constitution of the Society had to be drawn up, and I knew from experience, the simpler a Constitution is, the easier it is to work for any of the Officers. I was appointed Secretary and on 28 June 1950 these formalities were agreed between Professor Murray and myself. Now I could announce that the first Meeting and screening of scientific films would take place at the University's Wallace Theatre on 15 September.

Which films were shown on this historical occasion, I cannot now remember, but there was no lack of an audience. The Wallace Theatre has 250 seats and at these monthly screenings Professor Murray often said a few introductory remarks and then handed the meeting over to me. My work consisted in briefly introducing each film,—having of course previously seen it—and pointing out why I had chosen it for presentation and what were its particular virtues, both scientifically and cinematographically. This I enjoyed.

I was pleasantly surprised of the great choice that I could offer. There were many film libraries in Sydney, and the National Library in Canberra had a great store of historical films of considerable scientific interest. One film in particular, *90 Degrees South* was my favourite, being Herbert G. Ponting's record of Captain Scott's expedition in 1911 to the South Pole. Ponting, a member of Scott's team as 'camera artist', made this historical film under enormous difficulties in the Antarctic.[See Title 51] He had to hand-crank every foot of film and he developed it all in Scott's Hut near McMurdo Sound. It was always much applauded and admired. When it was projected at Buckingham Palace to King George V, he found it of such moral value that he wished every soldier to see it in the trenches.

Title 51

Herbert G. Ponting,'Camera Artist', in the Antarctic in 1911 with his then conventional cine camera which had to be cranked by hand at a uniform speed - but in addition Ponting developed and printed in the Antarctic every foot of film he had exposed. The resulting 60 minute long feature film *90° South* is one of the great classics in the history of motion pictures. *This frontispiece of Ponting's book,* Great White South, 1922, *was photographed by himself.*

It was Ponting's Film *90° South* which acted as a catalyst and introduced me to the Antarctic. In due course it led me to collect the classic literature of the early explorers and urged me to visit the Antarctic. (See Titles 187-201)

After I had returned to London, I discovered an easy way to deepen my knowledge of the Antarctic through the books of the explorers during the 'heroic' period. It lasted from Captain Cook's voyages in the late 18th century when he reached the ice shelf, until Captain Scott who in 1911 as the first tried to introduce mechanical transport—unsuccessfully—onto the Antarctic ice. When Admiral R.E. Byrd flew in 1926 to the North Pole and in 1928 to the South Pole, the era of polar technology had begun.

I shall mention on Title 73, that among the total of my 879 antique books, there were 123 which dealt with Polar Exploration of which the best 40 were sold by Christie's South Kensington at an auction on August 15 1988. A full catalogue was prepared, with a cover showing my example of *The South Polar Times;* it gave a detailed description of each book.

My copy of the *Times* was Number 117 of the limited edition of 250 and for me it was the most interesting and valuable of all. It had been written, typed, duplicated and some pages of it had been water coloured, by the members of the expedition in their hut while in the Antarctic, during Scott's voyage in 1902. There were many other treasures in the collection, such a Roald Amundsen's *Sydpolen*, describing how he reached as the first the South Pole, in the original Norwegian and the English translation. Then I had a copy of Charcot's *Pourquoi pas?* of 1906, and the description by Cherry-Garrard of *The worst Journey in the World* in its rare first edition of 1922. Earlier works of 1819 and 1824, Sir John Franklin's 1823 *Narrative,* the first American *Cruise* by Hooper 1884, Foster's *History* of 1786, and Nansen's *North Pole Expedition* of 1897—these were all very early and very valuable 'incunbula' of the polar literature.

The one book I did not sell and which lies beside me now is Herbert G. Ponting's *The Great White South* of 1922. To me it combines uniquely two historical themes, the antarctic and the cinematographic. My antarctic Temper has continued right to the present through Phillip Law, Australia's great explorer who has become such a good friend. The two excellent biographies by Kathleen Ralston, *A Man for Antarctica* and *Phillip Law, the Antarctic Exploration Years 1954-66,* tell how Phil had the vision and the success in his missions, now for over 50 years, to explore the Antarctic, his many adventures by sea and air and of his great contributions to Antarctic science. Australia can be proud to have these two great Antarctic heroes, Sir Douglas Mawson whom I met briefly in Adelaide [see Title 59] and Phil Law.

The word got around. After a few weeks, on 13 November 1950 I was asked to give my first talk on "The Cine Camera as a Scientific Instrument" at the Australian Institute of Instrument Technology, and a month later I talked to the Federation of New South Wales Film Societies about scientific films in general. These were the first of many talks, sometimes more academic, sometimes more popular, about the subject of scientific and research films. They were always illustrated with relevant examples, and thus it was no great chore to show, introduce and enjoy interesting films. I was always pleased with the audience reaction, invariably appreciative.

But this propaganda was to be a subsidiary effort, the main effort had to be to make research films, to demonstrate the real value of cinematography as a research tool. Again I was lucky in finding John Simons, a Senior Lecturer in Professor Murray's Department of Zoology, but unlucky in the choice of the subject, the axolotl. It was to be more a teaching film than a research film, but at least we discovered that facts in textbooks do not always correspond with reality.

The axolotl, *Ambystoma mexicanum,* is a salamander with short legs and unusual in retaining larval features, such as external gills. It is not an attractive animal, dark brown with black spots and about 25 cm long, including its long tail. The text book (*Encyclopaedia Britannica* in this case) states "Laboratory specimens sometimes change into a gill-less form, resembling the adult tiger salamander *Ambystoma tigrinum.*" It was our intention to film this change of the axolotl, the time it took to change, and to record the details of the direction of change, from head to tail or in the opposite direction,

But we could not induce this change. John Simons delved deeply into the zoological literature, introduced all possible and impossible chemicals into its watery habitat, but the Sydney variety simply refused to oblige. The camera was set up, the lights were turned on, whenever we thought a slight change in its structure had occurred, but after hours of waiting, nothing happened. Finally we gave up, after several weeks of frustration and failure.

John and I were luckier with our second project, a true research film, to settle the details of the blood's circulation in the heart of the frog. A controversy had arisen between him and Professor Foxon of Guys Hospital, London, and the short strip of film which I could record proved John's point. This even led to a letter in *Nature.* Later when John came to London, he worked in Professor Foxon's department, and John's advanced science talks on the BBC's Third Programme, became famous and a pioneering feature.

Life soon ran smoothly at 14 Sirius Avenue. We had delightful neighbours Nance and Ken Moulton, he the Head Science Master at the local Grammar School and she a devoted and highly skilled orchid grower. Later when I wrote my book *Research Films,* Nance typed the whole manuscript, an invaluable service for any author. Ken had been a prisoner of war in Japanese camps, but like many others I met, refused to talk about them. It was in June 1951 that Robert, our second child, was born in Sydney.

Soon I learnt that in Australia you just did not call a plumber or electrician, if anything needed fixing in the house, but did it yourself. For that you needed good tools, or if you did not have any, as I did not at that stage, you asked your friendly neighbour for the loan. Ken not only obliged with the hardware, but invariably gave the best possible advice, and actual help if he saw I could not cope myself. Ken was an excellent mechanic, and I shall always remember how he withdrew the rear axle of his small car, replaced a worn-out ball bearing and replaced the shaft again. The car ran perfectly afterwards. For maintenance of the Lagonda, he was a real God-sent neighbour.

Ann went on with her psychology studies and took part in a Conference in Melbourne, where she met a number of colleagues and in particular one from Perth whom she liked. I continued with my propaganda work for scientific films and in 1951 made some progress even outside Sydney. In April the Canberra Film Centre asked me to speak, in August I talked to the NSW Branch of the Motion Picture Technicians Association in Sydney and on 8 September the Australian Scientific Film Association was formed with representatives from Sydney, Melbourne and Canberra. Sir Marcus Oliphant agreed to be Patron. Finally in November, in the middle of a very hot summer, I talked to the Australian Library Association on 'Science and Cinematography".

A great supporter in my efforts was Noel Monkman and his delightful wife, Kitty. oel was at that time perhaps the only true scientific film producer in Australia. He ved at that time on Danger Island, near Brooklyn in NSW and later on Green Island in the Barrier Reef, Queensland. He made a number of outstanding biological films, some underwater, and one truly remarkable one recorded the giant turtle's way of laying its eggs in the sand. He was able to follow the emergence of the young turtles and their hazardous run to reach the sea. He kindly lent me copies of his films and I was able to screen them often during my talks. When he lived on the Barrier Reef, he built his own laboratory for filming and later I was able to visit him there.

But the real success came a year later, in September 1952, when I was able to organise a series of scientific film screenings during the biannual Meeting of the Australian and New Zealand Association for the Advancement of Science, ANZAAS for short. In that year the Meeting, attended by about 1500 scientists from all over the Commonwealth, took place at Sydney University and the Wallace Theatre was filled each day with a sizeable audience. My efforts were much appreciated, as the letters of thanks from the Officers of the Association testified. I was very pleased.

At that time, on 30 September 1952, I wrote a three-column full-page article with a photograph which was published in the *Sydney Morning Herald.* It had the title "How Instruments will record Atom Explosion" and referred to the British tests at Monte Bello Island, north of Australia. Most of the article praised high-speed cinematography at the relatively low level of about 2500 frames per second, which I could achieve with my camera. I knew little until much later, about the ultra-high speed drum cameras which are used as standard for atomic explosions with frequencies of several million frames per second.

I was glad to have this free editorial publicity for my work, which was entirely due to Tony Whitlock, at that time the Chief of Staff at the *Sydney Morning Herald.* He was a great amateur film maker and a frequent attender at my monthly scientific film screenings at Sydney University. At the time of the ANZAAS meeting and the Monte Bello tests, his superb news-sense chose a good subject for his paper and I admired him greatly in his important job. We became good friends and even made some amateur movies together in which our wives and we alternatively took parts or worked the cameras. One I remember was called "Jonny and Frankie were Lovers" and our two families swopped lovers—with results now long forgotten, but great fun at the time.

But back to serious work. In that year I gave two talks about my subject, one in Canberra to the Film Centre and one in Sydney to the Royal Society of New South Wales on "Science and Cinematography". It might be appropriate to say a few brief words about Canberra, the Federal Capital of the Commonwealth, but still a very unfinished Capital at that time. [See Title 316] I often visited the Australian National University, driving the Lagonda over the then rough country roads.

The Commonwealth was inaugurated in 1901, and in 1913 the US architect Burley Griffin was selected to plan the new Capital. The central ornamental lake, called after the architect, was still a dusty field when I first saw it, and only few of the grandiose new buildings had appeared. The new Parliament is today the greatest of them and I have always admired the town for its trees.

Talking and Writing Scientific Film Title 55

I began to realise in 1953 that making research films in Australia, as a full time job and a financial enterprise, would not succeed. There simply was not the demand and talking alone did not persuade anyone. One small research film did arise, about solar prominences, which were studied by Dr Giovanelli of the C.S.I.R.O. He had made a Lyot filter, and I attached a camera with time-lapse to his telescope, and thus these gigantic flares emanating from the Sun's surface moved gracefully across the screen when the film was projected.

Otherwise, I gave talks to the Ngunna Club in March, to the 5th Empire Mining Congress in April, to an Occupational Therapist Meeting in June, all in Sydney. In July I went to the Armidale University Film Festival and arranged the screening of 42 scientific films and wrote an article for the *Armidale Express.* There was no shortage of subjects, films and talks on which I was asked to help and in August it was 'Mental Health'. In September I had to judge the master pieces of the Australian Amateur Cine Society. In October I gave one talk on Underwater Cinematography, one to the Associated Television Company and another to the Institute for Photographic Illustrators.

When written as a diary of talks, it looks as if a career of an unpaid public speaker had taken the place of a rich research film maker. In fact, between each talk, there would have been many empty days, had I not decided to write my book about *Research Films* which I had planned after the Royal Institution Conference in London in October 1948.

The first thing I did was to buy a small booklet on 'How to Type with 10 Fingers' and for a week I followed the tedious finger exercises which meant to make me into a perfect Secretary. The second step was to draw up a plan of contents and this was so large that it became obvious it would have to be two volumes. The first volume was to deal with the history and hard ware of the subject as an introduction, followed by the biological sciences; the second volume would then be devoted to the physical and geographical sciences. My aim was nothing less than to survey all scientific research in the world since 1888, when Marey invented scientific cinematography, and to analyse what role research films had played in all these disciplines.

Such a world survey in 1953, without the possible help of computer and Internet would occupy many years, quite apart from the geographical difficulties of doing such a task from Sydney, equidistant thousands of kilometers from the great libraries of Europe and the USA. Of course I did not succeed and I was very glad that I could finish Volume I in a reasonable time and find one of the best possible publishers for it.

Writing a Book—My First Title 56

Two conditions are essential for writing a book, as no doubt every author in history has found out. As there are no textbooks on how to write a book, at least I have never found one, every author must for him- or herself rediscover that he needs the right psychological and the best possible physical infrastructure, just for composing his book's manuscript. Having it printed and published were another matter.

The psychological requirements are simple to state: There must be an all-transcending desire to write the great work, to sacrifice friends and even family, in order to preserve from interference the all too precious time of writing. If a daily allowance of some hours can be achieved, set aside for writing 500 words for an easy text, then a 160000 words book, *Research Films,* would require 320 days, say one year. But 500 words each day is the performance of a professional newspaper journalist. I certainly did not achieve this when I wrote my first book, when constant looking-up of historical references was required. Peace of mind, and absence of any financial worries, are other desiderata—nay, essentials—for composing a book.

The physical infrastructure is also simple to state. The transfer of words, from one's mind to a permanent base, has undergone a great technological evolution in history. From stylus to wax tablet, from pen and ink to paper and from mechanical typewriter to paper, were all preliminaries to the present electronic personal computer, with its great memory. If an author is lucky enough to devote himself full-time to writing, then he needs a regular supply of meals, warmth or air-conditioning, and of course a comfortable chair.

Not all authors have been so fortunate in the past; many had to fight against appalling conditions and yet achieved great works of literature—these were the geniuses who overcame all difficulties. I am here considering the average scientist like myself who wants to write a book and tries to make this lengthy task as easy for himself, and as efficient as possible.

At 14 Sirius Avenue in Sydney, I was lucky again and had a cool, large and quiet room in the basement—the hobby room as the estate agent called it—a solid Swiss Hermes portable typewriter, regular meals supplied by Nanny, as Ann had by then left me and lived in Perth. No financial worries, and the overwhelming desire to write about Research Films. My difficulties were of a different nature and I shall describe them below. I started work very early in the day when it was still cool, stopped for lunch and drank red wine copiously. At a fraction, 1/8 of a pound sterling per gallon, I could afford it!

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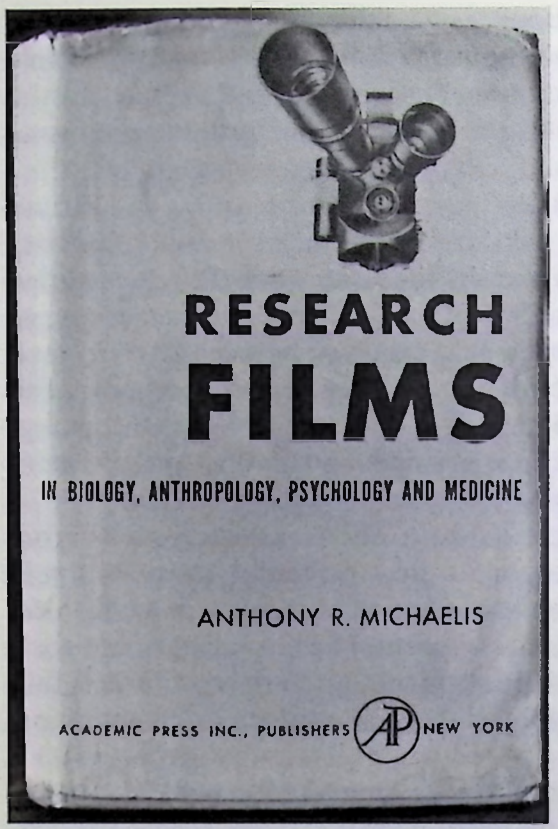
Not all authors have been so fortunate in the past; many had to fight against appalling conditions and yet achieved great works of literature—these were the geniuses who overcame all difficulties. I am here considering the average scientist like myself who wants to write a book and tries to make this lengthy task as easy for himself, and as efficient as possible.

At 14 Sirius Avenue in Sydney, I was lucky again and had a cool, large and quiet room in the basement—the hobby room as the estate agent called it—a solid Swiss Hermes portable typewriter, regular meals supplied by Nanny, as Ann had by then left me and lived in Perth. No financial worries, and the overwhelming desire to write about Research Films. My difficulties were of a different nature and I shall describe them below. I started work very early in the day when it was still cool, stopped for lunch and drank red wine copiously. At a fraction, 1/8 of a pound sterling per gallon, I could afford it!



Title 57

Cover picture of the **Author's first book**, written while living in Sydney. The cine camera was a French Eclair Caméflex which the Author owned and used frequently in his research work. The 490 page book, of which 1600 copies had been printed, cost £ 4 in 1956, was sold out after a few years. *Author's photogaph* ©

One of the disadvantages of 14 Sirius Avenue was the absence of any air conditioning, a rare luxury in Australia in the 1950s. After my copious drink of red wine at lunch time, I always took a siesta and slept for a an hour or so, and worked again later in the day when the 100% humidity and the 35 °C temperature had abated. Sydney lies at 33° Southern Latitude, equivalent roughly to Cairo and Shanghai in the northern hemisphere. Sydney's position as a Pacific Ocean Harbour raises its humidity to a typical, a tropical level, of 100%.

Writing about a subject that had not been reviewed for over 40 years simply meant that I had to read the original research publications to see if cinematography had played a decisive part. Xerographic reproduction was not yet available and when I found a reference to a relevant publication, I had to request a photographic copy of the text which I could obtain through the great kindness of the Librarian of the Fisher Library of the University of Sydney. As many of the early reports were published in French and German scientific journals, only available in European libraries, it inevitably meant a delay of several weeks before I could read and analyse it.

I started of course backwards. If I could obtain a recent publication which had used cinematography, and if the author had taken the trouble to refer to any similar previous work—a rare event, and almost never in case of an American author—I could then go back to the earlier quoted publication and thus proceed backwards. I had to write the text of course in a forward style and begin with the earliest use, for example of X-ray cinematography. To continue with this example: Kranzfelder and Schwinning had reviewed the subject up to 1913 when they published their own work using x-ray cinematography to analyse the effect of bullets on human bones. This paper was published by the Royal Prussian Ministry of War in Berlin in 1913 and must have been very difficult to find. But somehow I obtained it and could include it among the 1490 references, in this example Number 746, listed in the book.

Although it made my work more difficult and laborious, I decided to combine the alphabetic names of authors and the list of references in one single index. The above number of *(746),* before the alphabetic listing of Kranzfelder, thus made it easy to quote just the number in the actual text, for a quick referring to the details of the publication. If only a name was known, then the alphabetic order of names also made it easy to find the author's work. Finally I added, but only in proof, the page on which the text was discussed. A single entry in the Index thus combined Number, Reference and Page on one line. When completed, I found it very easy to find any required information, but I do not know if other authors copied this excellent, but rather laborious system in another book.

In my preface to the book I carefully defined what a 'Research Film' is and I limited it to Biology, Anthropology, Psychology and Medicine. On the title page I was described as Technical Director of SIMPL, a mere courtesy. The Preface bears the date March 1955 and the date of publication was 14 October 1955, with my London address of Park Road, having left Australia seven months previously. Sir Robert Watson-Watt very kindly wrote a foreword in which he extolled the value of scientific cinematography and stated that the author "had done a great service to science by assembling and ordering ... the valuable information ... in this encyclopaedic work". He went on that "He may be assured that here, there is no danger of finding 'Love's Labour's Lost'".

In fact, the writing of the book was just that: a 'Labour of Love'. The final royalties I received long after publication, I calculated, barely paid for the cigarettes I smoked while writing it. I learnt a great deal during the weeks and months of assembling "the impressively wide and deep range" [*W.-W.*] of scientific research carried out by means of the cine camera and I was struck by the inability of most scientists to read the literature before beginning their own work. Cinemicrography (cinematography through the microscope) was re-invented time and time again. Marey himself described it in his book *Le mouvement*, published in 1894 and the first extensive use occurred in 1910. The same comment is true for all the other techniques of scientific cinematography, which I described.

I also learnt very much science by reading the innumerable research reports, the building blocks of the book. Not all were included in the list of 1490 references but my knowledge was greatly increased in the biological, the human and the medical sciences which form the contents of the 'first' volume. A 'second' volume, dealing with the physical, geographical and engineering sciences was prepared by me at the same time, but unfortunately never reached publication. Its then completed manuscript is now preserved in the Manuscript Collection [MS 1216] of the National Library of Australia in Canberra. [Quantity: 5.4 m, available for reference]

I was lucky again in finding the Academic Press of New York as publisher through the personal recommendation of the Professor of Pharmacology of Sydney University. I sent part of the typescript to New York and received a letter from Kurt Jacoby, the senior editorial Vice-President, telling me that he liked it, but did not know any referees for the subject, and could I recommend two. Surely a unique response from a publisher! But then Jacoby, whom I unfortunately never met, was in many ways unique. Driven out of Germany by the Nazis, he arrived in New York with a briefcase full of manuscripts and from such humble beginnings, founded one of the greatest scientific publishing houses. I would have liked to thank him personally.

I left Sydney on board the *Stratheden,* P.O. Line, 28 July 1954, having spent there 4 years, 2 months and one day. Ann and the three children Bar, Robert [born 20 June 1951], Angela [born 23 September 1952] and Nanny were left behind, the Lagonda and my cinematographic equipment were sold, and I was bound for a Congress on High-Speed Cinematography in Paris where I was to give a paper. As I knew that I would never return again, I was sad to leave the children and depressed by my failure to pioneer scientific films in Australia.

The only success was the book. On board and in London I read proofs and wrote the Preface and the Dedication. Only in 1983, 30 years later, I learnt from Academic Press that they had printed 2008 copies, that they had sold 1514, and had given away about 100 complimentary copies. At that time 125 copies remained in stock in New York. They wrote to me that neither a reprint nor a second edition were justified, but that the copyright should be renewed, and to that I agreed.

The real pleasure I had from the book were the 35 reviews which were published in the photographic, scientific and cinematographic journals in many countries. They were all very complimentary and as they slowly reached me in London, they helped me over the sad loss of the children left behind in far distant Australia.

The return voyage on board a great liner was quite different from the outward one, four years earlier. While I worked on the proofs, there were many entertainments provided for the passengers and the meals were of a luxury standard. After Bombay there was always a magnificent curry buffet available at lunch time which I enjoyed very much. It was a leisurely trip with calls at Melbourne, Adelaide, Perth and Colombo reaching Tilbury on 1 September.

I must record my visit at Adelaide University to Sir Douglas Mawson (1882-1958) the famous Australian Antarctic explorer of the early 20th century. I knew of his films, taken during his expeditions and had described them in volume 'two' of the book. He received me most kindly and then went to the back of his office, where he had stored the many cans of original negative films, which he had kept so carefully, as he had thought. They were all on nitrate stock and when we opened one or two cans, we only found heaps of white powder. Sir Douglas was simply unaware of the inherent instability of the cellulose nitrate base of old films. They had been taken during the combined British, Australian and New Zealand Expedition which he directed during 1929-1931. All I could do was to advise him to transfer all to the National Film Library in Canberra which might still be able to save some cans.

In spite of all that I had lost in Australia, I found great pleasure again in London. My many old friends were all glad to see me and the absence of four years seemed to mean nothing, neither to them nor to me. I simply continued, working hard to finish the proofs of *Research Films,* went to SIMPL and helped with the making of research films. I had gone to Paris for the High Speed Cinematography Conference, read my paper and received a Medal from the City of Paris, just for attending it. I had a happy holiday afterwards with old friends from Sydney, Maurice and Marguerite de Bure, in the French countryside in their small Chateau in Beauplan.

It was a time of recovery. An old friend of mine, Standish Masterman offered me a basement flat in his house in 7 Hanover Terrace in Regents Park, perhaps one of the most desirable luxury locations in London. The Park is surrounded by magnificent Regency Houses, built by the famous architect Nash, and from them one had just to cross the road to be in the middle of the Park itself. The basement flat was really only the kitchen quarters of the once lordly mansion, and it had a huge kitchen and an even larger domestic cooking stove, which was put to good use when a French friend of mine came to visit me.

Henri Bel was a wool buyer for his firm in Roubaix whom I met in Sydney when both of us were collecting *moules* from the rocks on the beaches. He left Sydney before I did, but continued to buy wool in London and as I had space in my flat, both of us were glad to spend his visits to London together. He was a marvellous cook, and the first thing he did on arriving in London was to go to Soho to buy the ingredients for a *paté.* The great stove was ideal for cooking his six dishes of it, which lasted us for the week of his stay in London—with me. Once we were able to cook a whole suckling pig and we could give a grand party with various girl friends of mine.

Standish Masterman was a scientist who had inherited some money and could therefore afford the lease in Hanover Terrace. His wife Dodi was a painter and a well-known illustrator of books. They could not have been nicer to me when I returned rather miserably from Sydney. During the war Stanley had an exciting mission, through Iran and the USSR to Poland, round the back so to speak, to avoid German occupation troops. He had become a specialist in Rocket Fuels, and the first reports had reached Britain of Hitler's giant rockets to annihilate London. Naturally there was much concern about the size of these rockets, and it was correctly assumed that if the fuel capacity of the already existing rockets in Poland could be ascertained, the threat to London could be measured. Although carrying a charge of one ton of explosives, their impact was manageable, though terrible. [See A.F.S., Worst Job Title 29]

Title 61

Sir David Martin (left) with Sir Alan Hodgkin (right), the President of the Royal Society (1970–1975) at a Meeting in Washington DC in April 1971 with officers of the US National Academy of Science. In 1954, when I returned to England from Australia penniless, David Martin changed my life. He made me give up research films, pioneering but non-paying, and instead recommended me for a job as an Editor, never great wealth but always very exciting. *Courtesy The Royal Society, London.*

David Martin, (after 1970 Sir David) had more influence on 40 years of my career than anyone else. Early in January 1956 he was visited by John Jarrold, the owner and publisher of *Discovery, The Magazine of Scientific Progress,* who asked David Martin to suggest a successor to its Editor who had just left. David suggested me and on 26 January I met the Journal's owner, John Jarrold at 244 High Holborn, which was to become my Editorial Office. I was offered the Editorship at that interview, and as I liked John Jarrold for his sincerity, he was a Quaker, I accepted. [Title 62]

David Martin (1914-1976) was a Scotsman, born in Fife, and two years older than I. During the almost 30 years [1947-1976] when he was the Executive Secretary of the Royal Society, he acted as the most skilful organiser and administrator of science of the century. Although primarily a Servant of the Fellowship of the Royal Society, his influence extended over European, Commonwealth and World Science through his membership of the innumerable committees of scientists which he was instrumental in creating and guiding during his life.

He always seemed available for help and advice to anyone who needed it. The immense organisation necessary for the International Geophysical Year 1957-1958, the I.G.Y., flowed smoothly from his office, first in Burlington House and later from Carlton House Terrace, when an expansion of staff and space had become essential. He was a portly gentleman and carried it well, and when later he, Trevor Williams, the Editor of I.C.I.'s *Endeavour* and I, had monthly luncheons at our respective clubs to gossip about the latest scientific events, his enjoyment of good food and wine was a delight to see.

All three of us were chemists, David from Edinburgh, Trevor from Oxford and I from London, but David Martin's gifts were far greater than ours. His wide vision, his encyclopaedic knowledge of all important scientists, and not only in Britain, the way they worked and thought, he never appeared to be under any pressure, he always was a source of wisdom and encouragement, his ability to see broad issues while being meticulous about details were quite outstanding. Always sympathetic and helpful to all scientists, his sole interest in life was the Royal Society and its fellows. Kipling might have written *'IF"* with David Martin in mind.

The all too rare perfect obituary was written for him by Sir Harrie Massey and Sir Harold Thompson and was published in the *Biographical Memoirs of Fellows of the Royal Society,* November 1978. (David himself was of course never a Fellow himself, as the Society's statutes did not allow it).

Walk through the magnificent apartments of the Royal Society in London's Carlton House Terrace, and you will find the walls decorated with the paintings of its illustrious Fellows and other famous scientists. They range over the now more than three centuries of the Society's history, from its Founder King Charles II on, paintings of Isaac Newton, of Benjamin Franklin, Gottfried Wilhelm Leibniz, Christopher Wren, a bust of James Watt, and since 1941 a complete series of the Society's Presidents, nowadays commissioned by the Society. The total of 148 oil paintings and 24 portrait busts was catalogued in 1980 by the then Librarian Norman H. Robinson.

You can even find a small black-and-white photograph of Sir David Martin, in a dark corridor, although he has been considered by many as the most distinguished and effective servant of the Society in modern times. I have always felt that a portrait of him should be painted and prominently displayed to commemorate his great achievements and his services to the Society, as well as to science in general, not only in Britain but world-wide.

David was appointed Executive Secretary in 1946 at the age of 32, and one of his first tasks was to organise an International Conference on Scientific Information to which I was able to contribute a small paper. [See Title 33]

A major achievement of David's was to persuade the Society to become its own publisher of its journals, soon to be imitated by many other learned Societies. It brought a major revolution in the economics of the Royal Society and, instead of a deficit management, it achieved a major source of income which in turn led to an immense psychological benefit for all Fellows and staff.

In the later years of the 1950s Martin became intimately involved in the organisation of the International Geophysical Year 1957-1959. He created and chaired innumerable international committees, from which sprang the Antarctic Treaty of 1959, among other outstanding scientific developments.

Two further great contributions were the organisation of the Royal Society Tercentenary Celebrations in 1960, and I shall never forget David, wearing his academic gown and white gloves, proudly carrying the Society's Maze in front of the academic procession in the Albert Hall. Secondly, and perhaps even more significant for the future of the Society, was his supervision of the Society's move from Burlington House to the reconstructed premises of Carlton House Terrace, which at last permitted the full development of the Society's many activities. Surely, for these and his other achievements, he deserves proper recognition.

Title 62

The Russian ice-breaker Lenin was the title picture on the cover of *Discovery*, exactly 12 months after the launch of this atomic powered 16 000 ton vessel – surely a scoop for a monthly scientific journal. The author of the 6-page article, J.H.M. Sykes, was able to draw his material and his technical illustrations from the publications of the Second UN Conference on Peaceful Uses of Atomic Energy.
[See also Title 92.]

As it proudly proclaimed on its masthead each month, *THE MONTHLY MAGAZINE OF SCIENTIFIC PROGRESS* had its origin in 1920 and was then owned and published by the respected publishers Benn Brothers. When I was editing it, there was a complete set of all its past issues in the editorial office, but I do not know if they still exist, perhaps in Norwich in the office of Mr Jarrold's son and successor.

In 1930 the Copyright of the Journal was purchased by Cambridge University Press, but when the War situation became serious, and Cambridge, near the East Coast of England, feared a possible German invasion, the Press Syndicate of the University decided to close it down and suspend its publication in March 1940. The Editor at the time was C.P. Snow (1905-1980) later Lord Snow, the well-known Cambridge physicist and novelist (*The Two Cultures and the Scientific Revolution,* 1959) and later government administrator. He wrote a moving Editorial message in the last issue to be published from Cambridge, and hoped it would be resurrected in better times.

This is exactly what John Jarrold did in January 1943, before the end of the war, as he felt that a "Magazine of Scientific Progress" would be urgently needed in the post-war years to help Britain to regain its once eminent scientific position, lost during the war. Mr Jarrold was the owner of a very large and prestigious colour printing works in Norwich, East Anglia. Being a Quaker, he was not very interested in any financial profits of the Journal, and when it lost some income from decreasing advertisements, as happened from time to time, he may well have subsidised it privately. He appointed Bill Dick B.Sc. as Editor in 1945, after David S. Evans.

In a Publisher's announcement of my appointment as Editor, it stated that "Dick's many years of devoted work have made *Discovery* the Journal it is today". Its distinctive yellow cover could be found in the science laboratories of most British schools, in the homes of many scientists the world over, when a world wide distribution could again be arranged after the war, and of course in all scientific libraries of distinction. Its circulation was around 15000. As a monthly journal with only an Editor and a secretary in London, a great deal of copy editing and the complete lay-out had to be carried out in Norwich by some of the printer's staff. Dick had placed much emphasis on its pictorial excellence, a tradition I was happy to follow, and one or two pages of each issue carried full-page pictures. My task was to find interesting articles and authors who could write well, two desiderata which by no means always coincided. Once the typescripts and illustrations had been received and after their editing in my office, they were forwarded to Norwich for printing.

When I took over *Discovery* in April 1956, I found a certain number of separate Columns had become well established, like the first one, "The Progress of Science". It was the main editorial and could contain anything from one to twelve separate items, all unsigned. One or two might be written by the Editor himself, others might be commissioned, or they might originate from a reader. In this first issue of mine, April 1956, I might have written 'Atomic Power for Aircraft' or 'The Royal Society's Antarctic Expedition' or even both, as these two subjects interested me then. I cannot be certain now, as they were unsigned.

After "The Progress of Science" section came three or four main articles by well-known scientists about topical, historical or general scientific subjects which met with the Editor's approval and which he liked. In my first issue I had a contribution from Professor S.F. Singer on "The Artificial Earth Satellite", a proposal for a satellite to be called *Mouse. Sputnik* was not launched until 4 October 1957, a year and six months after the article was published. Also noteworthy was the contribution of Dr Derek J. Price on "The Prehistory of the Clock" in which he described his discovery of the *Antikythera mechanism* which was the first evidence of gears made by the Ancient Greeks. His discovery and analysis revolutionised our thoughts.

Further columns in my first Issue were "The Bookshelf", "New Scientific Instruments" and "Far and Near", the last column containing short news-items of a scientific nature. A few pages of advertisements followed at the end, including classified vacancies, appointments and items for sale. This issue of April 1956 contained 41 pages, each measuring 18 × 24 cm. From 1958 on, the size of the Journal was increased in width to that of the modern A4 size, but just about 2 cm shorter, no doubt to suit the convenience of the Printer—Owner, but also adding to the space available for the Editor.

I added to my second issue, May 1956, a new Column "The International Geophysical Year—Month by Month", composed of news items, maps, photographs and other relevant topics concerned with this great enterprise. The IGY was to start in July 1957, but world-wide preparations for it had already begun in 1956 and the 'year' lasted well into 1959, after being prolonged. The material for, and the writing of the Column, soon became the sole activity of Angela Croome, a most able contributor who much enjoyed this responsible task—it was the only regular monthly reporting about the IGY in the world and was read wherever scientists were working in connection with the IGY. No doubt, *Discovery's* circulation increased through it, and both Angela Croome and I were often complimented on it.

Halfway between the American Embassy in Grosvenor Square and Claridges Hotel, in the very heart of London's Mayfair, stands the house of the Savile Club at 69 Brook Street. It is a typical 'Gentlemen's Club' which still in the year 2000 does not elect ladies. I was elected a Member in June 1958.

The election procedure is simple: A member writes the candidate's name, his profession and his address into a large book, kept for this purpose. It is then left to other members, if they approve of the candidate, to add their own names, as a supporter. About eight supporters, after giving their reasons in writing, are generally considered sufficient for election. The book is analysed twice a year by the Selection Committee.

My Proposer was Frank Horrabin, the Map Artist who had designed most of the maps in the books of H.G. Wells and whom I knew well, as he had drawn many maps for my Journal *Discovery.* Among my supporters I was proud to have C.P. Snow, David Low the cartoonist, Michael Ayrton the artist, John Bunyan and Raymond Postgate. I had a total of 23. The Club has no political affiliation and my supporters were both of the right and of the left political persuasions.

During the more than now 40 years of my membership, I enjoyed every hour I spent at the Savile, eating many luncheons and dinners, talking and having a drink, always pleasant times during which I made many new friends. Being a scientist, this was surprising, as the present membership of the Savile is mainly 'artistic', with predominantly authors, script-writers, journalists, actors, film and television producers and musicians.

The Club was founded in 1868, and early literary members included Robert Louis Stevenson, H.G. Wells, Rudyard Kipling, Max Beerbohm, W.B. Yeats, Lytton Strachey, J.B. Priestley, A.P. Herbert and Thomas Hardy among others. The world of Music was represented by Sir Edward Elgar, Sir William Walton, Sir Arthur Bliss and Roger Quilter.

Famous Savilians were Henry Moore the sculptor, as well as Michael Powell and Emeric Pressburger, whose classic films *49th Parallel*', *The Life and Death of Colonel Blimp*' and *Red Shoes*, gave such pleasure to millions in the 1950s. Sir Ralph Richardson, the great actor was a Savilian, and so was Kingsley Martin, the caustic editor, Sir William Osler historian of medicine, and others, lawyers and judges. Lesley Plummer, the politician, was a Savilian and the full list can be found in *Hang up your Halo in the Hall,* the Club's excellent history by Garrett Anderson, published by the Savile Club in 1993.

Until I read Anderson's book, I never realised what an honour it was to belong to a Club which has had amongst its past members so many of England's greatest scientists. A founder member in 1868 was Sir Norman Lockyer FRS, pioneer of astrophysics and remembered also as the founder of the London Science Museum and the Journal *Nature*, of which he remained the Editor until his death in 1920. His discussions to start *Nature* with Alexander MacMillan, the publisher, took place at the Savile and *Nature* was published by the company of his name.

In the 32 years between the Club's foundation and 1900, no fewer than 168 Fellows of the Royal Society had been elected members of the Savile, including eight Presidents of the Royal Society. Here I can only give a brief list of famous scientists including Karl Pearson FRS, the founder of modern statistics, A.N. Whitehead FRS, with Lord Russell as co-author, of *Principia mathematica,* Sir Arthur Eddington FRS the astronomer and mathematician, and John Tyndall FRS of the Royal Institution, a successor to Faraday.

Famous for psychiatric care was Dr Henry Maudsley FRCP, after whom the great Hospital for mental diseases in Dulwich, South London, was named in 1923. Another famous Savilian was Sir William Thomson FRS, later Baron Kelvin, who discovered the second law of thermodynamics and whose initial 'K' has been given to the absolute temperature scale. Equally famous was Lord Rayleigh FRS, Nobel Laureate, the discoverer of inert gases, especially argon. Another early Nobel Laureate and Member of the Savile was Sir Joseph John (J.J.) Thomson FRS, the discoverer of the electron. Perhaps the most distinguished scientist who was a member of the Savile, was Lord Rutherford, generally regarded as the founder of modern physics. He was also a Nobel Laureate and a President of the Royal Society.

More recent Fellows of the Royal Society who also received the Nobel Prize were Sir John Cockcroft who was the first to split an atom in 1932. Later, when he was the Director of the Harwell Atomic Energy Research Station I applied there for a position as a scientific cinematographer and Sir John interviewed me at the Savile Club in 1955, but I was not appointed. I also met Sir Cyril Hinshelwood, a very special President of the Royal Society, as in 1960 he officiated at the Tercentenary Celebrations of the Royal Society. He was also a Nobel Laureate, though not a frequent visitor of the Club.

During the last 40 years, when I was a member, and after the deaths of Cockcroft and Hinshelwood, no further famous scientists were elected members of the Savile Club.

Title 63 C

Herbert George Wells, born in Bromley Kent in 1866, died in Hanover Terrace, Regents Park, London in 1946. At the age of 18 he received a scholarship to study biology at the Royal College of Science, South Kensington, also the Author's College. H. G. Wells graduated in 1888. In his first two books published, *Textbook of Biology, Part I Vertebrata*, and *Part II Invertebrates and Plants*, Wells describes himself in 1893 as B. Sc. London, F.Z.S. and 'Lecturer in Biology at University Tutorial College'.

These publications would never have made him world-famous, but his next books *The Time Machine* 1895, *The War of the Worlds* 1898 and *The first Men in the Moon* 1901, showed Wells, as the author of these astronomical fantasies, to be a writer of great scientific imagination, of vigour, vitality, nay exuberance. His many subsequent volumes of social themes, comic novels, even a historical treatise, showed Wells to be undeviating and fearless in his efforts for social equality, world peace and the future good of humanity, often brought about by the rightful use of science.

I felt a great affinity for Wells, I had studied at the same College and I am a member of the same Club, the Savile, but above all, I found in many of his writings a basic philosophy which I have here called the 'Scientific Temper'.

Caricature by David Low, a member of the Savile, published as Supplement to The New Statesman, *16 January 1926. (Author's Collection)*

The Savile Club's Motto: *Sodalitas convivium* Title 63 C

I don't know if every Club has a motto, but I do know that the Savile Club's motto expresses perfectly the behaviour and feeling of its members. A simple translation of *sodalitas* would be 'comradeship'. But I would prefer 'solidarity', which is defined as "The fact or quality of a community of being perfectly united, or at one in some respect of its interests or sympathies". This represents admirably the Savile Club's *convivium,* namely its general spirit of 'feast' or 'entertainment', while being in the Club.

The Savile appeals to me, and undoubtedly to its other members, because of its free and easy atmosphere, its liberal style and the graciousness of its beautiful House. Its code of behaviour, (dress: tie and jacket) bans any social misdemeanour, although occasional drunkenness has occurred. Here is an example.

Not all candidates are elected, as for example Lord George Brown, the deputy Prime Minister of a past Labour Government. At a guest dinner to meet new candidates, he got so drunk that he committed the unforgivable sin of making a speech, advocating his suitability as a member. He was asked to leave the table and was so inebriated that he fell down the splendid curved staircase leading from the dining room and landed oblivious of his surroundings at the bottom. His proposer withdrew his name. (From Anderson's history)

Sir John Cockcroft defined the spirit of the Savile admirably: "I take my acquaintances to the Athenaeum, but my friends to the Savile". The Athenaeum which historically accepted as members only the Aristocracy, Bishops and Fellows of the Royal Society, has in recent years, presumably for financial reasons, lowered its entrance conditions, but has retained the traditional and conventional atmosphere of its establishment.

In contrast, the Savile has always remained casual and informal, corresponding naturally to the character of its 'artistic' membership. At the Savile it is a tradition that members are expected, even encouraged, to speak freely to each other, at all times and everywhere in the Club—except at the Breakfast Table!

Only one great scandal is recorded in the Club's history, when H.G. Wells seduced the daughter of a fellow member and used this affair as the plot for his book *Ann Veronica.* Her father, Mr Reeves, the Director of the London School of Economics, never forgave him, and even the generally tolerant Members of the Committee asked Wells to resign. For the next 28 years Wells used the Athenaeum, but in 1937 returned to the Savile, where he was once again received with much pleasure. (Anderson)

In May 1959 and again in March 1960 I could report in *Discovery* my impressions of two countries I had never seen before, Israel and Algeria. There were great differences between the two, politically, scientifically and socially, yet both were new in the impact science had on each of them.

I flew to Tel Aviv at the invitation of Israeli friends who had some money to spare from their 10th Anniversary Celebrations of Independence in 1948. We were several English science writers and we stayed for two and a half weeks during which we saw all that was scientifically interesting. At the Weizmann Institute I met its distinguished scientists, Michaelis (polymers), DeShalit (atomic physics), Katchalski (biophysics), Feldmann (biology), Gillis (mathematics), Sondheimer (organic chemistry), Sela, (cell biology), Schmidt (inorganic chemistry) and David Samuel (isotopes).

We were driven through the Negev desert to Eilat on the shore of the Red Sea and stayed in the kibbutz Kafar Blum. In Jerusalem we interviewed its famous Mayor Kolleg, Miriam Ballaban (publisher) and at the University Samburski (philosophy), as well as a charming lady, Hanna Sobel (biology), Kugelmann (psychology) and Stein (chemistry).

It was a hectic visit with appointments every hour or so, relieved only by the silence of the desert and the warm welcome I received everywhere, as of course my Journal was respected and well-known. I much admired what had been achieved in Israel during the 11 years since Independence and recorded my impressions. in *Discovery* as 'Harness the Sun', 'Deluge the Desert', 'Teach Technology', 'Serve Humanity', 'Find the Future' and other such essays with similar titles. My report occupied 15 pages, of which about one half were photographs.

My second journey, to Algiers, at that time still French Colonial Territory, was perhaps more dramatic, but less interesting scientifically. It was again a group of science writers who was invited, this time by the French Administration and we were impressed by the Solar Furnace in the Sahara, the Nuclear Research Institute of the University of Algiers, Missile Research at Colomb Béchar, where a night firing of a rocket was shown to us, the oil and gas technology in the Sahara and the hydroponic research at Béni Abbès. On my return I published 21 pages, again half of them photographs. Algeria was more interesting from a technological point of view, whereas Israel impressed us more through its emphasis on basic science and its promise for the future. The Scientific Temper was much in evidence in Israel, although science also played an important part in the development of its Defence Forces.

I enjoyed editing as I could write an article and publish it immediately. I had always been an admirer of Jules Verne, joined the French Jules Verne Society and travelled to some of their meetings in France. In the June 1960 *Discovery* I published "Jules Verne's Extraordinary Scientific Voyages" in which I examined the basis for his correct predictions. I was able to compare original illustrations from his first editions, of which at the time I had a complete collection, with modern photographs of technological achievements such as a balloon flight over Africa, a helicopter with forward propeller engines, a submarine at the North Pole and a rocket flight to the Moon. But I could not find a modern equivalent to Jules Verne's *Epouvante* (1904), a triphibious craft for travel on land, under the sea and flying in the air.

When in early 1960 I received an offer from Dr Paul Erni of CIBA, Basle, to work for his great company in London, I wondered at first if there would be any editing, but when I was offered double the salary I received from Mr Jarrold (£ 1500) I accepted with pleasure. Dr Erni was Head of Press and Information for the worldwide CIBA Group and a person I soon learnt to admire for his good taste and his excellent style with which he endowed everything for which he was responsible, all graphic, printed and published CIBA materials. He influenced me greatly in all my subsequent work and we remained good life-long friends.

One of my first tasks was to produce a book *CIBA in Britain* for which I engaged the best industrial photographer in England, Walter Nürnberg, with whom I travelled to Horsham, Duxford and Manchester where CIBA had laboratories and production facilities in Britain. Walter Nürnberg took endless trouble with each photograph, adjusting his powerful lights, and the many excellent pictures he submitted fully justified his reputation. I wrote the text, and although a final page proof was produced and accepted by Dr Erni, the English Managing Director, Sir Arthur de Vere Harvey, cancelled publication for reasons best known only to himself. I still have the page proofs and am proud to have produced this book within 12 months of joining CIBA.

I joined CIBA on 2 July 1960 and travelled a very great deal during the following years, frequently to Basle where I always stayed at the Euler Hotel and had many friendly discussions with Dr Erni and his Basle Colleagues. I was particularly impressed with Dr Robert Käppeli, the Chairman and Managing Director of CIBA in Basle and thus the Head of the International Chemical Group CIBA. He had the same taste and style as Dr Erni and was much admired by the staff I met in Basle. What I thought were proper objects to collect for a cultured gentleman in his position, were antique Greek gold coins. I was once able to admire a large number of these, but of course could not judge them, as at that time I knew nothing about Numismatics.

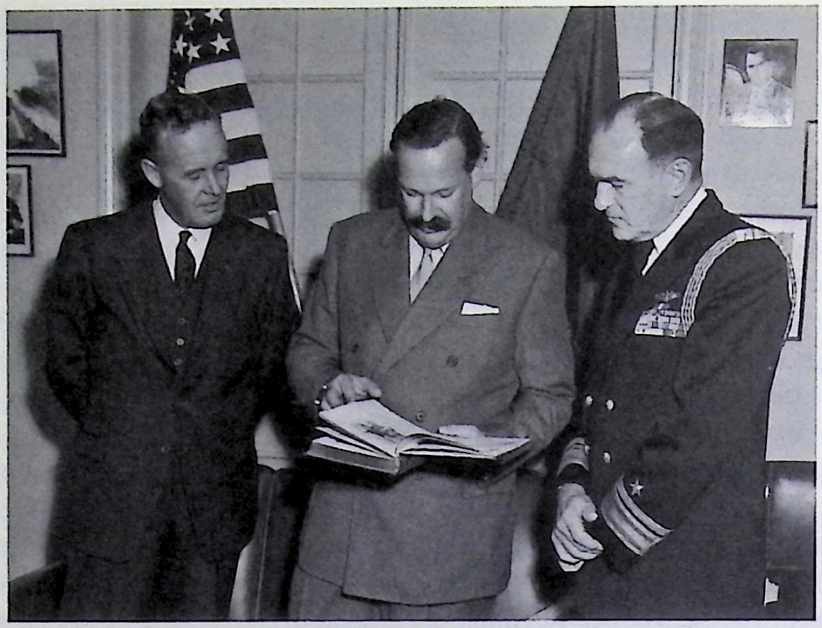
In 1934 CIBA published a splendid book, copiously illustrated in colour, commemorating the first 50 years of its international history. CIBA is an abbreviation for Chemische Industrie in Basle, the Society of Chemical Industry in Basle. In 1959, on its 75th Anniversary, an even more luxurious publication, some bound in full vellum, and again lavishly illustrated in colour, traced the history of Basle from the Middle ages and the prehistory of chemistry and chemical Industry in that city. One could be proud to be part of this fine tradition of publishing, and I was sad that I could not have contributed to it through *CIBA in Britain*.

CIBA had for a long time been truly international and when I was given a new task, namely to mount CIBA's stand at the International Trade Fair in New Delhi in February 1961, I was delighted. Preparations for the stand were planned a long time ahead, the stand was completely erected in Basle, taken to pieces again, packed in screwed-down wooden cases and shipped in good time. I was given a number of large screw drivers in case the local workmen were unable to open the cases. All went well and the Stand was much admired and visited by Nehru. My duty was to supervise and scientifically explain to distinguished visitors any questions they might ask and, mostly, I could do this.

On my way to Delhi, I stopped in Bombay and met the local directors. Near Bombay on a beautiful wooded site, CIBA had just opened a new chemical research laboratory to be staffed entirely by Indian scientists. It was the second example of how Dr Käppeli overcame trade profit export restrictions of a country in which CIBA operated. He simply invested in the national talent of the country, as research results were easily and internationally transferable.

The Ciba Foundation in London was Käppeli's first success. In its magnificent Nash house at 41 Portland Place, London W 1, medical and scientific meetings have been held and pleasant guest rooms for visiting scientists provided, their discussions were published and widely distributed, and as long as in England the same restrictions were operative as in India, no better investment for trading profits was imaginable for the prestige of CIBA. Its first director, Dr Gordon Wolstenholme, was able to build up quickly the Foundation's international reputation which it continues to enjoy to this day.

In comparison, the Eidophor can only be considered as a partial success. It was a colour television projection system, capable of producing pictures on a cinema-size screen. It was cumbersome, and when I introduced it at a meeting of the British Association in Norwich in 1961, it had to be transported in two special trucks from Switzerland. The results were admired by all, but apart from special medical or scientific meetings, it found little other use. I published a detailed description of it in *Discovery* in December 1959, page 520.



Title 67

One year after the end of our BBC French broadcasts about *Voyages Interplanétaires*, the news was released in Washington in August 1958 that the most spectacular voyage still possible on our Planet had been achieved: A submarine, the **USS *Nautilus*, had reached the North Pole submerged** under the ice and made the first trans-polar crossing from the Pacific to the Atlantic ocean.
To commemorate this event, I decided to present a copy of Jules Verne's first luxury edition of *20 000 Lieues sous les Mers*, the *Edition polychrome*, to Commander William R. Anderson USN of the USS *Nautilus*, to acquaint him with Jules Verne's story of his imaginary *Nautilus* cruising below the ice of the South Pole. Handing over the original French book at the Headquarters of the US Navy in London is recorded in this photograph with Rear Admiral Robert W. Cavenagh USN, US Naval Attaché London (right) and Captain A. Davis RN, British Naval Intelligence (left) looking on, as the author (centre) turns a page. The book was published in Paris in 1870 and I had searched for a year to find a copy *(Official US Navy Photograph*, published in *Navy Times* on 24 November 1959).

In addition to editing *Discovery* I always did other work, mostly writing but also broadcasting and some television. So, when I was sacked by the British Managing Director of CIBA for refusing to write a semi-political speech for him as a Member of Parliament, I was not worried about my future livelihood, particularly as Dr Erni saw to it that I received a 'silver' handshake.

My freelance article with the greatest number of readers was called 'The Breeding Storm' and was a whole page in *The Guardian* of 21 November 1961. It dealt with the ever growing number of people on planet Earth. It was reprinted on the front page of the *San Francisco Chronicle,* four days later and I was very proud. I took as my text a statement by Professor A.V. Hill:

> *"If ethical principles deny our right to do evil in order that good may come, are we justified in doing good when the foreseeable consequence is evil?"*

To this day, there has not been a satisfactory solution to the world population explosion, except through birth control. Many prejudices still prevent its efficient use for all who want and need it. [See Title 388]

At the invitation of the French Service of the BBC in London, an integral part of its World Service, Arthur Garratt and I produced for 6 months a twice weekly 30-minute programme. In 1956 we aimed to foretell human space travel, (the first unmanned satellite, *Sputnik* was not launched till October 1957) and we decided to imitate Jules Verne who had called all his books at the end of the last century *Voyages Extraordinaires.* Based on strictly known scientific facts, we extrapolated to the best of our knowledge and suitably dramatised, our *Voyages Interplanétaires.* They were received in France with some acclaim.

Arthur Garratt was a brilliant physicist with some private means which allowed him great independence of thought and action. He was a true professional in broadcasting and later television and was widely used as an 'anchor-man' for scientific programmes. In our team work he provided the basic physics and the dramatic episodes, whereas I was perhaps best in the extrapolations. We covered all stages from launching manned rockets from Earth to a permanent lunar base and we stipulated an 'International Interplanetary Authority' for these broadcasts. We gave all astronauts a different nationality and an appropriate national name. Our excellent professional BBC producer was French, Pierre Rollin.

On our Paris press conference organised by the BBC, I met a charming lady, called Gloria de Medinacelli. We promptly named the doctor at the Moon base after her. But when later she refused my invitations, she was unfortunately struck by a meteorite at the lunar base and killed. *Sic transit gloria lunae.*

When in November 1985 I was proposed for membership of the Cosmos Club in Washington D.C., I was required to submit a list of my publications. This I had never prepared before and after much searching and researching, it amounted to 7 1/2 typed pages of titles and references, then 105 items. As several items covered regular monthly editorials, the total is by now far greater [See total List in Appendix II, Bibliography, Title 428].

I am listing a few here, to give a general impression.

A monthly column of book reviews in '*Books of the Month*', London
'Conquering Space' in *TV Times,* London 1957
'Partners into Space' a letter to *The Times* London, 14 August 1958
'Collecting old scientific instruments' *The Listener*, London 1958
' I believe' *Seminar,* New Delhi, 1961 [Title 105]

'Medals of Science', *New Scientist,* London 1961
'How nuclear energy was foretold', *New Scientist,* London 1962
'Scientific Ballooning' *Panorama,* Basle 1962
'Living underwater' *The Guardian,* London 1962
'Cancer' *World Health,* Geneva 1962

'Weights' *Panorama,* Basle 1962
'The Restoration of Science in Germany' *New Scientist*, London 1963
'London's neglected Science Museum' *New Scientist,* London 1963
'Essay in Myth Creation' *New Scientist,* London 1963. A Book Review of Olaf Stapeldon's '*Last and First Man*'.
'Collecting old scientific Books' *New Scientist,* London 1970

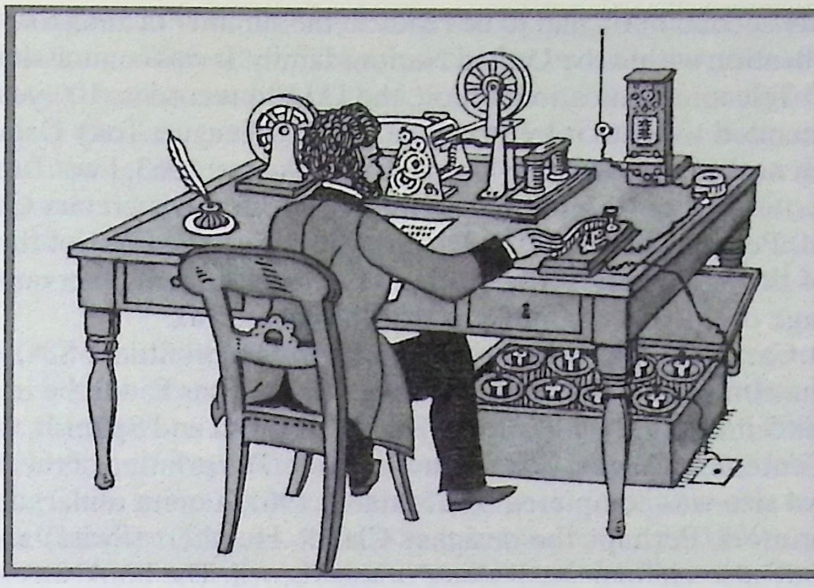
'Decimalisation of British Currency' *New Scientist,* London 1971
'Disasters Past and Future' Booklet published by *Daily Telegraph* 1972
'Is the Chunnel just asking for the Moon?' *Congressional Record,* Washington DC republished from *Daily Telegraph,* London 1973
'Der elektronische Krieg vom Yom Kippur' *Die Zeit,* Hamburg 1974
'The Numismatics of Astronomy' *Vistas in Astronomy,* Oxford 1980

'Adapt or Perish' *Precambrian Research,* Amsterdam 1980
'The Interdisciplinary Philosophy' *Kagaku,* Tokyo 1980
'Water Colours for Science' *Leonardo,* Oxford 1982

This list does not include the almost daily consulting work on *Technology,* MacDonald's book, London 1963, to which I contributed some chapters, such as road vehicles and space transportation.

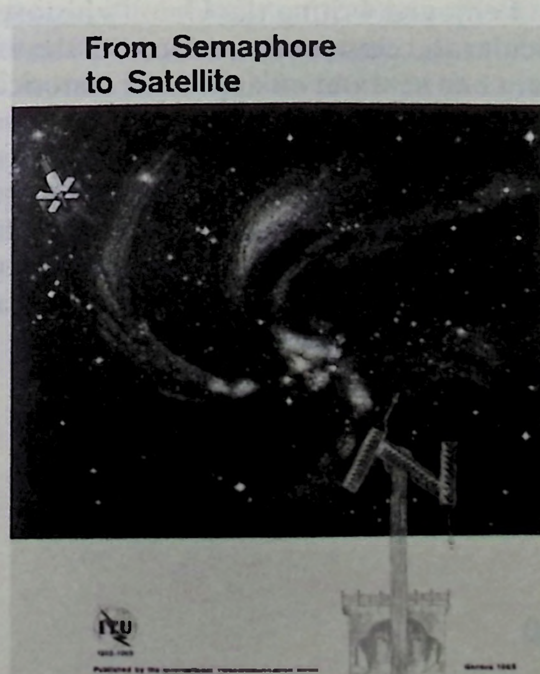
Title 69

Telegraphic transmission, using the **Morse Code**, by an official of the German Postal Authority in 1863, at the time of the foundation of the ITU. *Courtesy Deutsche Postreklame.*



Title 69

Cover Picture for the **Centenary Book** of the International Telecommunication Union, published in Geneva in 1965 and written by the Author. The deep blue picture with a semaphore on the right and a satellite in the top left corner was designed by the Swiss artist Claude Humbert, who designed the whole lay-out of the 343 page work in English, French and Spanish. It was printed by Henri Studer SA Geneva and cost SwF 10 on publication. It was soon sold out but never reprinted. *(Author's photograph ©)*



My second book had to be ready in the summer of 1965 for the first Centenary Celebration within the United Nations family. It was commissioned by the International Telecommunication Union, the ITU, to record its 100-year history. I was recommended to write it by a science writer colleague, Tony Osman. On my first visit to Geneva, the seat of the Union, on 8-9 August 1963, I was formally commissioned to write the book, and I met Gerald C. Gross, the Secretary General (American) and M. Persain (French), the Director of External Affairs of the ITU. For the duration of this commission I became an International Civil Servant which had the advantage that I was not liable to British Income Tax.

Careful calculations with the Printers Henri Studer S.A. of Geneva showed that the completed manuscript with all illustrations had to be in their hands by January 1965 if the three editions, in English, French and Spanish, were to be ready for the Centenary Celebrations in the summer. The printing of the 344 page book of nearly A4 size was completed on 15 March 1965, a quite remarkable achievement by the printers. Perhaps the designer Claude Humbert (Swiss) and the author (British), may also claim a small share in this record. The book was a complete success, distributed world-wide by the ITU at a price of 10 Swiss Francs, and the three language editions were soon sold out, but it was never reprinted. I called it *From Semaphore to Satellite.*

I therefore had 17 months—of which two were spent as a Fulbright Scholar on a Grand Tour of the United States to collect material for the book—to write about 100 years of technological history and of international co-operation, as well as the social and political implications of the telecommunication revolution which took place during those 100 years. The Union—but not the book—started with electrical telegraphy in Paris in 1865 with 20 states as members and the book ended in 1965 when there were 125 member-states, when the orbits and frequencies of satellites had to be allocated and television from the Moon was forecast. (It did occur four years after publication.)

I enjoyed writing the Union's history, my frequent visits to Geneva, and in particular the close cooperation with the excellent designer Claude Humbert. M. Persain had sent out an appeal for historical illustrations to all Members of the Union and as a result, both designer and author could choose from a very rich source of information. Pictures and text grew together in harmony.

I concluded—although I did not put these thoughts into the book—that the history of the Union over 100 years, with its uncountable Committee Meetings attended by so many different nationalities, does prove that international cooperation can lead to success, although a long time scale must be tolerated. This lesson should be learnt by all politicians.

My first Visit to the USA—as 'Foreign Leader' Title 69A

My first step towards writing the ITU Centenary Book was to make sure that I had the necessary information from all Member Countries, but I soon discovered that I missed most of the historical background from the USA. I discussed this with Mr Gerald Gross, the Secretary General of the ITU, himself an American. He assured me that I should go to America and interview Government Officials and Industrial experts who could inform me. It took only a few weeks before I received an official letter from the US Embassy in London in late December 1963 "Inviting me as a participant in the Foreign Leader Program to visit the United States for a period of sixty days".

I was then sent Form DSP-66 from the State Department entitled 'Certificate of Eligibility for Exchange Visitor Status' and Form DS-1006 which stated that I would have economy jet transport to and from the US, but first class jet transport from Washington to San Francisco. I arrived in Washington D.C. on 4 January 1964 and stayed at the Cosmos Club, as the Club had reciprocal guest facilities with my London Club, the Savile Club [see Title 63 A] of which I was elected in 1958 and still am a member today. In 1986 I was also elected a Member of the Cosmos Club in Washington [see Title 306] and in 1997 became an Emeritus Member.

The first memorable impression of the visit was the flight itself, and in particular the vast ice fields which we crossed on our northerly route over Greenland. These I had never seen before, and I was glad of the safety record of British Airways. On my many subsequent flights to and from the States I took safety for granted, and flying over Greenland became routine. IAD, the official name of Dulles Airport, about 40 km outside Washington, was equally impressive; its very modern and grandiose architecture as well as its location in the open countryside, very different from my European travels.

The first famous American I met was Senator Barry Goldwater, the Republican candidate for the Presidential Election of 1964. The State Department official who received me at Dulles Airport knew him well enough to introduce me briefly and Goldwater, like a true politician, addressed a few polite words to me. From my first impressions on, which could not have been better, the whole visit turned out to be a great success. I stayed later at the Waldorf Astoria Hotel in New York, at the special academic rate of $ 25 a night and drove down by car with Geoffrey Brigstocke, then a Counsellor at the British Embassy in Washington and a very good friend, [see about his tragic death Title 281] to Cape Kennedy in Florida, where we both were fully briefed by NASA officials about the American Space Program. We were lucky and watched the launch of a small satellite.

As I had been invited for a 60 days visit and as there were so many people and institutions which I wanted to contact, I decided to split my invitation and to spend the first 30 days on the East coast and the second part in the Middle and West of the American Continent. On my second day, Sunday 5 January 1964, I visited in the morning the Air and Space Collection (Not yet the Museum) of the Smithsonian Institution and the Pre-Columbian Collection at Dumbarton Oaks. For these two museums alone, it was worth crossing the Atlantic.

The week was hardly long enough to see all, and so I began with the Telecommunication experts of the State Department, my sponsors. Years later they showed me in in their own building the unique and special Disaster Office which had world wide communication facilities. My diary of the time is crowded with appointments at the Department of Commerce, the Pentagon, NASA, FCC and the British Embassy. From Washington I flew to New York by Shuttle, another fascinating innovation for me, and went from LaGuardia Airport by limousine to New Haven, Connecticut, where my old friend Derek Price had invited me for the weekend. [See Title 404]

Derek Price, one of the greatest historians of science, was by then Avalon Professor of the History of Science and Medicine at Yale University. He was the first to discover and mathematically describe the 'Exponential Growth of Science' and I could discuss with him the exponential growth of communications, through telegraph, telephone, radio and television, during the 100 year period which was covered in my book. I learnt a great deal from him at the time, which later found its way into the text of my book.

The next two weeks were divided between New York and Washington, with visits to Bell Laboratories, COMSAT and INTELSAT, being the most important. Then on to Cape Kennedy with Geoffrey Brigstocke, and after a few days there, he had to return to Washington, whereas I flew on to Miami and San Juan in Puerto Rico where I took part in the ARECIBO Conference and saw the giant radio-telescope buried below ground level in its hollow.

The reason for this was an invitation by Tommy Gold FRS, the Professor of Astronomy at Cornell University, an old friend who had been interned with me in Canada. Near San Juan he had directed the construction of a very large radio telescope, using for this purpose a natural hollow in the ground which was covered internally with wire netting. From three large towers on the rim of the hollow, a steerable receiver was suspended at its centre, at the focus 'for electromagnetic radiation coming from the universe'. It had not yet been fully constructed and I remember climbing into the receiver station, 100 m above the ground, without any safety guides. I returned to London via Lisbon in February 1964.

Title 70

Probably the rarest item in my collection was a pair of **Queen Anne's Woolweights**, having been cast during her reign 1702 to 1714. Each of these, weighing 7 lb, but joined together by a leather strap, was hung over the saddle of an official called trantor, who was riding through the country weighing the wool crop. From this weight the tax was calculated. They are very rare, as at the death of each sovereign they were melted down and a new king's crest was cast. *Author's Collection.*

Collecting can be great fun, as it means constant contact with people. One learns tremendously from the subject or objects one collects. It need not be in excess of one's available surplus money, but it demands a great deal of effort and application to increase the collection above other, comparable ones. Finally, a difficulty will arise towards the end of the collector's life, namely how to preserve the precious items, avoiding a public auction and renewed dispersal of the collectables, if the family does not share the collector's taste and does not want to inherit it. [See also Title 331 about collecting]

When I became aware that I had a small surplus of money, I became a collector, and that was on my return from Australia to England in 1954. I had just finished my survey of scientific research in many disciplines by scientific cinematography, and collecting scientific instruments seemed an obvious subject for me. I lived in London, by car only a few minutes away from Portobello Road, the Mecca of all collectors, and I soon became a regular visitor there on Saturday mornings. It was a real revelation to me that the history of science, about which I had only read in the literature was, through its instruments, readily available for purchase in Portobello Road.

There was one small shop, belonging to Evelyn Butler, which specialised in scientific instruments. She was not a scientist herself but, during the years of her successful trading, had acquired a great fund of knowledge about old telescopes, microscopes, sextants, ancient weights and other scientific collectables. I noticed soon that I was not the only regular customer in her shop and thus an exclusive group of friends established itself quite naturally, who proudly told each other of their latest finds or asked for advice from whoever was more knowledgeable than the happy new owner of a rare item.

My own collection grew slowly and one of my price items was a Georgian table telescope with a reflecting mirror of 3 inches for which I paid £ 15, a reasonable price at the time. I also had two microscopes of the Culpepper type, early Italian telescopes made of cardboard with lenses at both ends, and an ebony sextant with an inlaid silver scale of degrees.

The Astrolabe is of all antique scientific instruments the oldest, the most desirable, the rarest and the most expensive. The first, Arabic ones, date from about 1000 AD. It is commonly described as an astronomical and astrological circular 'slide rule' which allows the positions of stars to be determined in the past and in the future by a simple movement of a circular pointer, the rete, over another circular plate. As each Astrolabe always had to be calculated individually and hand-crafted, this explains its rarity, value and its aesthetic beauty.

The two Astrolabe Societies Title 71

When Evelyn Butler, the owner of the shop in 77 Portobello Road, decided to retire in the summer of 1965, our special group of regular customers decided to continue our friendly discussions on a more formal basis. We called it 'The Astrolabe Society, London'. We met regularly once a week at each others home, showed our collections, and soon gave talks about subjects we thought were interesting to each other. Membership was open to 'owners of scientific collections' and its aims and objects were 'to further knowledge of antique scientific instruments and subjects.'

The themes of our talks, which we grandiloquently called 'Transactions' and typed out, dealt with 'The Use of Napier's Bones' Robert Seligman; 'Hadley's Quadrant' R. Seligman; 'Globes, terrestrial and celestial up to 1530' John Didcock; 'Ship Models' Edmund Thring; 'Explorers of the Moon' Patrick Moore; 'Medals of Science', Anthony Michaelis; and two further talks by J. Didcock about 'Globes', the last one on 8 February 1967.

The Society had 22 members in 1968, 11 English, 6 French and 5 Americans, but when the Secretary, Evelyn Butler, became seriously ill, the Society gradually declined. Phoenix-like it was reborn as the 'Société Internationale de l'Astrolabe' of Paris, and it held its first General Meeting on 12 November 1976. By then it had 61 gentlemen and four ladies as members, mostly from Europe and the United States with residents in France predominating. I was again elected President and Alain Brieux Secretary.

The most important person was Alain Brieux, the most knowledgeable dealer of antique scientific instruments in Europe at the time.The publication of learned papers, to be called *Astrolabica,* was achieved by the International Society, many of them dealing with Astrolabes and their historical relevance, fully deserving the adjective 'learned'. The third Meeting took place at Greenwich in the summer of 1978 and set the pattern for the future of the Society. All 24 French members were deeply impressed with the magnificent collection of Astrolabes at the Old Royal Observatory, and from this arose the desire to travel world-wide and see other astrolabe collections, however few or distant they were.

The pattern emerged of one meeting in Paris, followed on alternative years by one in 1980 in Bruxelles, 1982 in Oxford, 1984 Chicago, 1986 Florence, 1988 The Netherlands and 1990 Scotland, the 25th Anniversary of the foundation of the Astrolabe Society, London. Today this pattern continues under the Secretary Anthony Turner who took the place of Alain Brieux after his death. I resigned as President in 1996, when I left London and Anthony Turner became President which, at the time of writing, he is continuing with great devotion to the International Society along well established lines.

Title 72

Exhibiting Moon maps in 1973 at the library of the University of Houston, I had the opportunity of explaining to the University's Chancellor, Dr Alfred Neumann, how closely the antique map of 1630, drawn by Cassini, resembled the photographs taken during the Apollo flights. [See also Title 331].

Courtesy Houston Post ©

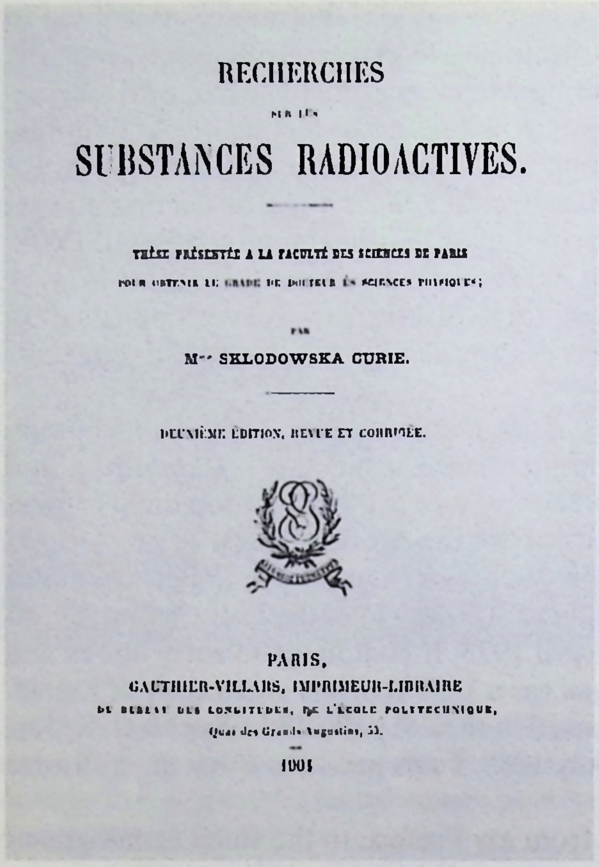
All results of scientific research must be communicated if they are to contribute to the progress of science, and since the written, and later the printed word was the only means of doing so, it is obviously of importance for any historian of science to collect the *Editio princeps* of scientific books. When my collecting of old scientific instruments became too expensive, I changed my acquisitive activities to books, for which London was of course an ideal place. Even if I could not afford a first edition by the Hon. Robert Boyle, several hundred pounds Sterling in the 1950s and 1960s, I was happy to spend £100 for Napier's first Continental edition, Lugduvini 1619, of his *Logarithmorum Canonis.* It is the first Table of Logarithms ever published on the European Continent, in the same year as the *Editio princeps* appeared in Scotland.

My exploding library had but one dominant feature, its *Scientific Temper*—Science, past, present and future. One example was the subject of *Selenography,* and as I had reported for *The Daily Telegraph* almost all the Apollo Moon flights, it was natural to collect all possible early books about the Moon, as well as many of its rare antique maps. I was invited to exhibit the major items of the Collection under the title "The Image of the Moon—Galileo to Apollo 11" at the Library of the University of Houston, Texas, from 16-27 April 1973. It contained 43 early books and maps, including Galileo's *Siderius nuncius* (as a 1655 reprint) and a copy of the actual chart which Armstrong and Aldrin used in their Apollo 11 Lunar Module during their descent to Tranquility Bay in July 1969. I was proud to show my treasures to an appreciative audience.

I should like to quote one paragraph from my Preface to the small Catalogue of the Houston Exhibition:

> *This dream [of reaching the Moon] must be kept alive, now more than ever, when a brief recession in the forward march of selenology has occurred. Man will return to the Moon—soon! The history of geography has taught us that whatever has once been discovered, will be visited again and again, until it becomes a permanent settlement.*

I had hoped that the exhibition in Houston would lead to the acquisition of the whole Collection by some Texas Institution, interested enough in the contribution which Texas had made to the whole Apollo Project, but I was disappointed. In the end I donated my whole Selenography Collection to the Space Museum in Huntsville, Alabama. It was there that Wernher von Braun and his team of engineers had designed, developed and tested the Apollo rockets.


RECHERCHES

SUR LES

SUBSTANCES RADIOACTIVES.

THÈSE PRÉSENTÉE A LA FACULTÉ DES SCIENCES DE PARIS

POUR OBTENIR LE GRADE DE DOCTEUR ÈS SCIENCES PHYSIQUES;

PAR

Mme SKLODOWSKA CURIE.

DEUXIÈME ÉDITION, REVUE ET CORRIGÉE.

PARIS,

GAUTHIER-VILLARS, IMPRIMEUR-LIBRAIRE

DU BUREAU DES LONGITUDES, DE L'ÉCOLE POLYTECHNIQUE,

Quai des Grands-Augustins, 55.

1904

Title 73

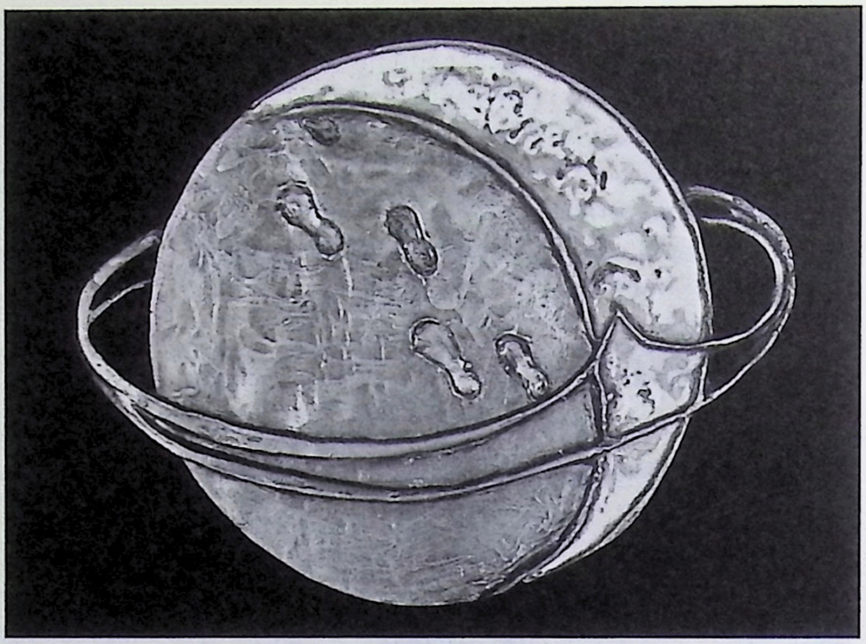
I always liked **Mary Curie's doctoral thesis**, one of the rarer items in my collection of scientific publications. Although it was only the second edition, also published in 1904 like the first, it must have been popular at the time, as it was the first printed document about the newly discovered "Radioactive substances".
photograph from the Author's collection.

Collecting old scientific books is really quite easy in London, one must know the scientific temper. Then one must spend as much time as one can afford in book shops, likely to have desirable books at a reasonable price. Continue for a decade, and a collection of beautiful leather bound books will cover one wall in your home. See my article on this, *New Scientist,* 24 Dec. 1970.

There were many other subjects apart from the Moon, of which I tried to find early scientific books. Here, I shall give a list of some subjects and one special book in each:

ARCTIC AND ANTARCTIC		
J. Franklin	*The Polar Sea* 1823	+ 123 other early books
ASTRONAUTICS		
H. J. Oberth	*Wege zur Raumschiffahrt* 1929	+ 200 books
ASTRONOMY		
Apianus	*Quadrans* 1532	+ 108 early books
AVIATION		
S. P. Langley	*Memoir on mechanical flight,* 1911	+ 66 books
GEOGRAPHY		
Anderson	*Cook's Voyages* 1781	+ 18 other early books
INSTRUMENTS, SCIENTIFIC		
Bion	*Traité des instruments* 1725	+ 60 other early books
OCEANOGRAPHY		
M.F. Maury	*Physical Geography of the Sea* 1855	+ 60 books
PHYSICS, EARLY		
I. Newton	*System of the World* 1728	+ 141 other early books
RADIOACTIVITY		
Marie S. Curie	*Thèse* 1904	+ 54 other early books
SUN AND PLANETS		
P. Lowell	*Mars and its Canals* 1906	+ 49 other early books

It was quite a good collection, and was later acquired by the Hochschule Holzen.



Title 74

Many medals were struck to commemorate **Apollo 11**, but I found this French Medal, coloured enamel on bronze, of man's first foot steps on the Moon, 20–21 July 1969, the most beautiful. Struck by the Paris Mint, its diameter is 120 mm, excluding the orbits. *Photograph Courtesy Ronan Picture Library.*

It must have been in the 1950s that one of the antique dealers in Portobello Road came up to me and said "As you collect old scientific things, would you like this medal?"I looked at it, saw the face of Newton and the date 1726, the year of his death, and I asked the dealer "How much is it?" He soon replied, "Half-a Crown" (one-eighth of a £ sterling). I bought it, and thus began the third of my major collections. The bronze medal was then more than 200 years old, in very good condition and the price ridiculously small.

I had no idea how to collect other medals showing either scientists or engineers or their achievements, but argued correctly that if one such medal exists, there must be others. Fortunately I soon found Baldwin's shop in 11 Adelphi Terrace, the Strand, London's oldest dealers in rare coins, established in 1872. On my naive question, "Have you any scientific medals?" the present Mr Baldwin just pointed to a very large open wooden box, full of all sorts of medals, and said "You can look through those!" It must have contained 1000 old medals, and my task of looking through them began. To follow one's scientific Temper is not always easy!

I found a great many, as no-one had ever before looked for scientific medals. In a later lecture I defined them:

> *Numismatic items which have a direct relationship to science, recording and commemorating scientists and their achievements, whether of pure or applied, physical, biological or social nature.*

It took less than 10 years to accumulate several hundred medals, not all from Baldwin, but also from many other sources. Friends who happened to come across any, a few more from Portobello Road, all helped to increase the collection and London proved ideal for collecting. Housing them was not easy, a beautiful wooden cabinet collapsed from their weight, and a steel cabinet with shallow draws was the answer.

My first discovery was the great variety of materials from which they had been made. From jasper (Wedgewood cameos), porcelain (Dresden) and German silver, through bronze, copper, titanium, silver, gold to platinum and even lava, I had specimen of each material, except platinum which I knew existed, but could not afford to buy. Then I discovered that the number of coins which had the portray of a scientist was extremely small, only Auer von Welsbach (Austria 1958), Santos Dumont (Brazil ND), Zeppelin (Germany 1930), Newton (England 1793), Copernicus (Poland 1959), Planck (Germany 1958), and Franklin (USA 1951) was all I could collect. These coins were of course struck in an edition of many millions,whereas a scientific medal would only reach few tens and very rarely perhaps 100. When I reached the age of 75 in 1991, American friends gave me as a present the means and the inspiration to design my own medal and have it struck by the Paris Mint. [See Title 439A]

As far as I could find out, scientific medals had never been collected before, nor was there any reference to them in the literature. To my mind they formed one of the few bridges between the two cultures, the arts and the sciences, and for that reason alone, they should be described and exhibited. Each is a miniature work of art, and, if struck in a suitable metal, they are, in addition, the most permanent record possible of science. They commemorate great scientific and engineering achievements which their contemporaries considered worthy of recording in a special and lasting form. So for example, space flight in the 1960s and the 1970s produced a plethora of medals, but only a few astronauts had portrait medals struck.

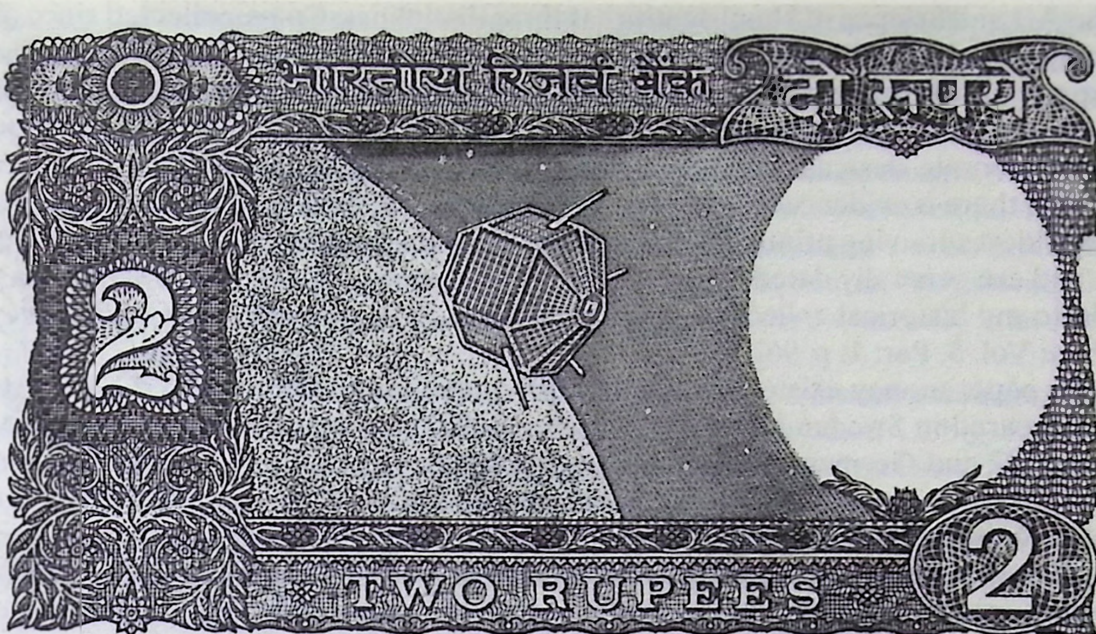
For 26 years, from 1961 to 1987, I lectured, wrote and exhibited them, until the collection was acquired by the Deutsche Museum in Munich. My first major article appeared in the *New Scientist* November 1961, followed in June 1963 in *Panorama.* Almost ten years later I was invited by Philip Handler, President of the National Academy of Sciences, Washington, to exhibit 250 of my medals at their Annual Meeting in 1972 which proved a great success. Two years later I could do the same at the Royal Society, London, during their annual Conversazione, through an invitation by Sir Eric Denton FRS.

I had the second major article published in the May 1975 issue of *Endeavour*, and this was followed in 1978 by a further exhibition in Innsbruck, Austria, on the occasion of the 110th Meeting of the Gesellschaft Deutscher Naturforscher und Ärzte, through the invitation of Professor Dr Peter Sitte, the President. In June 1980 I wrote an article on the "Numismatics of Astronomy" for *Vistas in Astronomy* and in September of the following year, 1981, the British Association for the Advancement of Science celebrated its 150th Anniversary in York, and I was invited by Sir Frederick Dayton, the President, to exhibit.

My greatest honour was to give one of the famous Friday Evening Discourses at the Royal Institution on 10 February 1984, through the invitation of Sir George Porter, the Director. It was a full dress affair, dinner jacket for speaker and audience, and the lecture, with two projectors, uniquely showed obverse and reverse of each medal simultaneously. By tradition the lecture must last exactly 60 minutes, timed to the second. A bell strikes as the lecturer enters and 59 minutes and 59 seconds later, he must finish with his last word.

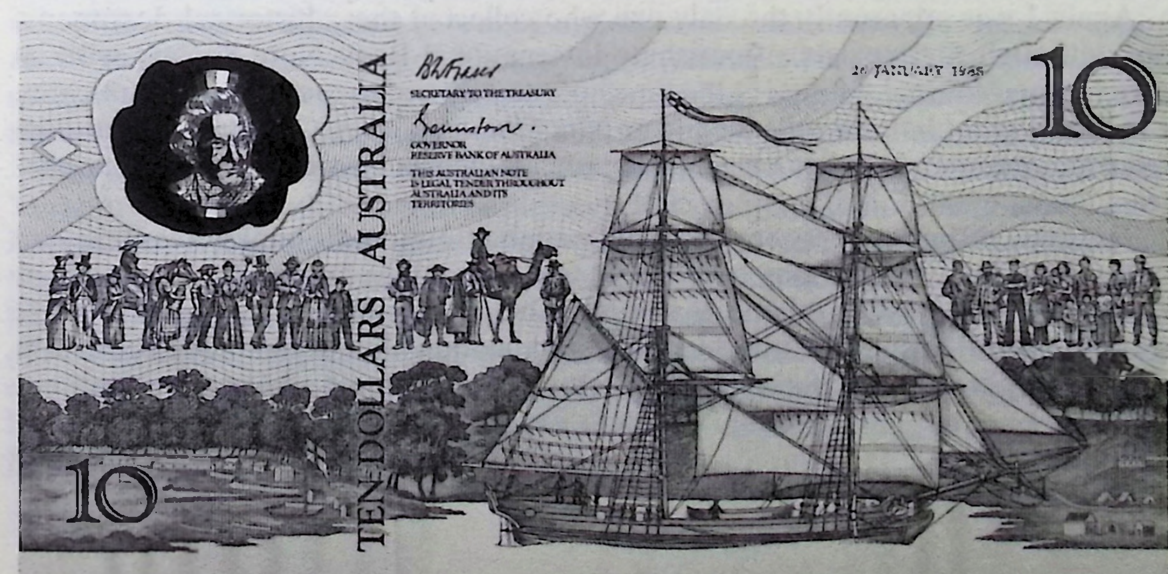
In 1986, for the 600 Year Anniversary Celebrations of the University of Heidelberg, the Rector, Professor Gisbert zu Putlitz invited me to exhibit and this took place at the Dresdner Bank, Heidelberg, in September. I wrote one more article for my own Journal, *Interdisciplinary Science Reviews* (10/4) in December 1985 [See Title 344] and gave one more major lecture about Scientific Medals to the Cosmos Club on 11 May 1987.

Exhibitions
1972 National Academy, Washington
1974 Royal Society, London
1978 G.D.N.Ä., Innsbruck
1981 British Association, York
1986 University 600 years, Heidelberg



Title 76

India's 2 rupee banknote has so far remained the only one to show a spacecraft, manned or unmanned, on a national currency issue. The astronomical satellite was launched by a Russian rocket in 1975 and is named **Aryabhata** after a Hindu astronomer of the 5th century. The banknote measures 65 x 105 mm. *Author's collection.*



Title 76

The first plastic **Polymer Banknote** with an OVD design was the Australian $ 10 note, issued on 26 January 1988 to celebrate the country's bicentennial. The OVD, the Optically Variable Design, is based on a Moiré pattern and makes it impossible to reproduce the banknote on a colour photo copying machine. In this banknote the OVD is the picture of Captain Cook surrounded by a transparent background, here appearing as deep black. *Author's collection.*

The Art and Science of Numismatics has three disciplines: Coins, collected since antiquity; Medals, gathered since the Renaissance, and Banknotes, which, with their strange history, have been collected only during the last 100 years. Few will realise that the Chinese invented the first banknotes, printed from a carved wood block with elaborate designs onto paper made from the bark of the mulberry tree. Although there is evidence that the first were printed in 1023 AD, none have survived. The oldest surviving printed banknotes date from the beginning of the Ming dynasty, and are generally dated 1375 AD. I was fortunate to find a genuine specimen to add to my historical collection. [See Joseph Needham, *Science and Civilisation in China* Vol. 5, Part 1, p. 96]

No paper money existed for the next 300 years, and the first printed banknotes re-appeared in Sweden in 1661, in America 1690, France 1720, Russia 1768, England 1797 and Germany 1806. These early examples had only graphic designs and the first black-and-white pictorial banknotes were printed by the multitude of private banks in North America from the middle of the 19th century onwards. These small banks, here today and gone tomorrow, wanted to advertise to their clients their monetary strength, their security and their modernity by having pictures on their banknotes of the latest technological achievements, like railways, steamships and electric telegraphs. These I collected if I could find and afford them.

Colour security printing advanced slowly. Only since the end of World War II have I found banknotes with portraits of scientists and engineers, or their achievements, which I could include in my collection following the same definition which I used for scientific medals [see Title 74]. I began collecting at the beginning of the 1980s and by 1997, when my collection was acquired by the Deutsches Technikmuseum in Berlin, the total was 1300 scientific banknotes from all over the world.

Again I was apparently the only one who collected these historical documents and although there exists a flourishing International Bank Note Society with its own learned Journal, I found at the time no-one with whom to exchange duplicates. I received great help in collecting from Mrs Claire Lobel of Coincraft in London, from the Journal of the Society and from friends who had travelled to distant countries.

The main difference between scientific medals and scientific banknotes is the size of their editions. Medals may be struck in tens or rarely in hundreds, whereas banknotes are issued by the million or multiples thereof. I estimated that by 1997 there were 20000 different banknotes in circulation worldwide but that only about 5 % showed any scientific or technological pictures which I could add to my collection.

Whereas the material of medals varied widely, banknotes were always printed on best natural fibre based papers until very recently. Then in 1988 Banknote Printing, a branch of the Australian Reserve Bank, introduced plastic polymer based notes which incorporated holograms visible from both sides. This great chemical improvement to prevent counterfeiting is of course one of the basic criteria of a good banknote, apart from a striking motive. For me the picture was the essential desired item for my collection. As in the case of the scientific medal, there was no literature on the subject and no-one with whom I could exchange duplicates. Only during the last few years have I known of two other collectors, but they were only interested in physics on banknotes.

My first article "Banknotes of Chemistry" appeared in *Chemistry and Industry* March 1983 and contained five portraits of chemists, Weizmann, Liebig, Katchir-Katchalsky, Auer von Welsbach and Böttger on various banknotes. I also illustrated the article with German Notgeld of 1922, issued and printed by Bayer and BASF. A more comprehensive article "Banknotes of Science—A neglected Art of Science and Technology" was written and published by me in *Interdisciplinary Science Reviews* in September 1988, where I could cite a table of 56 famous scientists of many different disciplines on banknotes in my collection. The article was translated into German and published in *Naturwissenschaftliche Rundschau* in November 1990 and it was reprinted in the *Journal of the I.B.N.S.* I had also written a brief note about "Australia's scientific Banknotes" in my own Journal *ISR*, December 1987.

One year after the inauguration of the first Australian polymer banknote with holograms, I was fortunate in publishing in *ISR* [Vol. 14, p. 399, 1989] an article by Dr D.H. Solomon of CSIRO Clayton, Australia, about the scientific research and the development of the polymer production technology of these notes. It was the first scientific article of this new process. I myself wrote a little later for the *Journal of IBNS* Vol. 32, No. 3, a survey of this new subject, and called it "OVD The Bank Notes of the Future". OVD stands for *Optically Variable Designs* and will be the generic name for holograms in banknotes. IBNS is the International Banknote Society.

There has only been one exhibition of my banknote collection at the Museum für Verkehr und Technik—after 1 September 1996 the Deutsches Technikmuseum, Berlin. The Director, Professor Günter Gottmann invited me, and from June till September 1991, 175 scientific and technological banknotes were shown to the public. Good press notices appeared in a number of newspapers. During the exhibition period there was one attempt to steal the German DM 200 note, showing Ehrlich, but a vigilant Museum attendant foiled the thief. My collection is now permanently housed at this Museum. A CD ROM Catalogue is slowly being prepared by the Museum.

Soon after the war ended in 1945, English scientists could again discuss how to improve the world-wide exchange of ideas, interrupted for so long in some cases. It was David Martin of the Royal Society in London who had the brilliant idea to call an International Conference in 1948 on the subject of "Scientific Information" with J.D. Bernal giving the opening address. Among the many contributions to the theme, I submitted a paper on the use of punched cards. [See Title 33] Each one would contain all relevant information about a single scientist, his research topic, qualifications, publications and address. If one scientist wanted to know his co-workers in the same field, all cards would have to be run through the then existing primitive sorters, a lengthy and quite impracticable task. Even today with Internet and e-mail no such search is possible, as there is no world-wide data base of all scientists.

In November 1962 I made another proposal, to start *The Science Daily* Newspaper. I had just spent a few months on the Staff of the London *Daily Telegraph* as a temporary replacement for the Science Correspondent, Anthony Smith, on safari in Africa. [See Title 83] I thought I knew all about a daily newspaper—except the vital matter of financing it! I still have a copy of the five-page memorandum on the subject, about Editorial Policy, contents sub-divided according to disciplines with relevant advertisements on opposite pages, staff, office facilities, distribution and initial print order. I argued that if specialist newspapers like the *Financial Times* and *The Wall Street Journal* could exist and make a profit, so why not one for scientists world-wide? The idea was then just too utopian!

Ten years later, I was able to start a project that was more practicable and profitable. It had been decided that in February 1971 English currency would go decimal and much opposition existed because it was argued that no-one could rapidly convert in his head the new into the old currency. I had just then in 1968 acquired a facsimile of Apianus' *Astronomicus Caesareum* originally published in 1543. The reprint, like the original, had many splendid volvelles, the circular paper slide rules, which allowed the reader to calculate easily any given positions of the Moon or of the stars, throughout the year.

My simple idea was to construct such a circular slide rule with one circular scale of the new currency values outside and another circular scale inside with the old currency. One could easily rotate a cursor also provided, all made from stout cardboard. My employer, then the *Daily Telegraph,* took up the idea enthusiastically, advertised it in its columns, and sold many thousands of these gadgets for many months. I received a royalty which was much to be preferred to a patent. When the EURO currency appeared, the same idea was no longer possible, I discovered, as electronic calculators had become universal. [See Title 217]

SNS—A special Project Title 79

SNS stood for Science News Service, a joint project of Jack Henry and myself to sell to newspapers scientific and medical news items and articles by prominent authors. Jack was a manager of one of Britain's leading news agencies and could privately help me to distribute such scientific material which I could write and commission. We started on June 1, 1962 and could achieve not inconsiderable success, but in the end, we could not make it financially worthwhile.

We had beautiful blue paper with our logo printed and the following stories were written and distributed:

New British Oceanographic Research Ship *Discovery*
British Atomic Fusion Research
Male Birth Control Pills
Slim on High-Fat Diet
American and Russian Race to reach Earth's Inner Mantle
Space Station needed to reach the Moon
Life on other Planets
Diamonds—The Soldiers best Friends
Spying has become a Science
World TV will show Moon Landing—Geostationary Satellites
(Distributed on 7 September 1962, achieved seven years later!)
Inner Space and Seabed Robots
Gas Turbine Cars

We charged only £ 3 for each story printed, and of course lost heavily at that small fee. Nevertheless the following newspapers used our material and printed one or the other of the above stories:

Guardian Journal, Nottingham
Liverpool Echo
Evening Times, Glasgow, two items
Express and Star, Birmingham
Sunday Press, Ireland
Evening Dispatch, Edinburgh
Evening Post, Lancashire, two items

The 12 articles we distributed were used in 9 newspapers, hardly a great return on the effort we expanded on writing and distributing them. We were pleased that they were printed uncut, often as a double spread in the centre of the papers. That we were right in offering this service, although much in advance of time, was proved by the fact that again and again such science news services were set up in Britain and the United States. I do not know if they were financially more successful than we were.

Not having a permanent job, I was able to engage in a number of freelance activities—a risky state of affairs for any family man with responsibilities. However, being divorced at the time, I greatly enjoyed some of these activities. So for example I very much appreciated being elected for several years as the Chairman of the Association of British Science Writers, a professional organisation of which I had been a member for many years. I could rely on an excellent Secretary, Peter Cooper then of the Royal Society, who was not only knowledgeable in all matters of scientific policy, but also extremely hard working in this, for him a purely voluntary activity. We organised visits to laboratories and factories and invited eminent scientists to our lunches to inform us 'off the record'. Many years later, I was again honoured by the A.B.S.W. by my election as a Life Member, the highest grade of membership.

I am also a Member of the International Science Writers Association which is based in the United States of America. Its members, all professional science writers, are distributed all over the world, and when visiting a strange country, which I had often to do for the *Daily Telegraph,* I always found a helpful colleague. I also joined for a short time the *Club of Rome,* but found its highly theoretical discussions about the state of the world not very practical.

Another proposal of mine in 1963, *A Science Year Book* was challenging, but not successful. It was based on *Whitaker's—The World in one Volume,* an annually updated encyclopaedic almanac. I drew up a Contents List of what such an almanac should contain for Science. The major disciplines would start with an annual review of progress, then list the professional societies of the world in that field, the major journals, and then specifically for each discipline special items, for example for the astronomers a list of radio telescopes, a list of expeditions for geographers, of zoological gardens for zoologists, of elements for chemists, and of atomic particles for physicists. It also had a travel section and one part devoted to the communication of science. But, however useful it might have proved, I could not find a sponsor.

I did not neglect my science writing and was pleased to be asked to contribute two large chapters to the Oxford University Press' *History of Technology,* one on 'Cinematography' [Volume V, page 734] and the other [Volume VII, page 857] on 'Space Technology'. I was also happy to act as Special Consultant and Contributor to *Technology—Man remakes his World* of the Macdonald Illustrated Library, London 1963, for which I wrote three Contributions: 'Reshaping our World', 'Building Road Vehicles' and 'Space Transport'. J. Bronowski and Sir Julian Huxley were editors, Hans Erni illustrator and designer.

I R O—The Helping Hand Title 81

The Royal Army Medical Corps organised at its Training Centre in Mytchett, Hampshire, England, from the 6-8 October 1972, an Exercise called HELPING HAND. It was defined as 'An enquiry into the Means whereby Medical Aid could be provided in Natural Disasters'. I was honoured to give the opening keynote address which I called "Disasters Past and Future". As I was at the time a Staff Member of the *Daily Telegraph,* their Managing Director kindly ordered the printing of 1000 copies of my lecture for distribution to the V.I.P. audience. The British Director General of Army Medical Services, Lieutenant General Sir Norman Talbot, invited his colleagues of equivalent rank and seniority of the Royal Navy and The Royal Air Force as well as his colleagues from the USA, Canada, France and Australia. It was the most distinguished medical audience I ever addressed, all senior staff of the Army Medical Services from many parts of the world.

I had been deeply concerned about the lack of any International Rescue Organisation, an I.R.O., when reporting in the *Daily Telegraph* about technological accidents, and even worse about the muddles, inefficiencies and duplications which always occurred when individual countries sent aid for the victims of natural disasters, like floods, earthquakes, volcanic eruptions and hurricanes. At the time, one of the greatest disasters was a flood in East Pakistan in 1970 where the official estimate was 1 million people drowned.

My first pleading for 'International Rescue' was published in the *Daily Telegraph Magazine* in November 1967, and I repeated this appeal when I reported about the Floods in East Pakistan. These articles may have been the reason why I was asked to give the keynote address at 'Exercise Helping Hand'—I was never told officially. However, this invitation and my large files on the subject of disasters allowed me to propose details for an I.R.O. which I incorporated in my review of past disasters and forecast of future ones.

I laid down Rescue Priorities consisting of the Establishment of a Chain of Command, followed by Reconnaissance, the re-establishment of Communications, the evacuation of the injured, mobile hospitals, evacuation of disaster survivors and provision of water as well as sanitation for them, followed by the supply of food, clothing, heating and shelter.

A basic requirement for any efficient International Rescue Organisation would be to stockpile essential means for rescue and for aid to survivors. Such stockpiles should be located along the equator, allowing for the most rapid air dispatch to any disaster area in the Northern or Southern Hemisphere. Although these considerations were simple common sense, they have never been put into practice, and sad to report, never been implemented. Thirty years later, nothing has changed.

Disaster research is to ask scientific questions about Acts of God. After giving my lecture in 1972 at the 'Exercise Helping Hand' and pleading for the setting up of an International Rescue Organisation, the IRO, I pursued the subject in a number of articles and came to the conclusion that there was great ignorance about disaster prevention, about rescue during disasters and the treatment of disaster victims afterwards, particularly psychological aid. Disaster research was a novel subject, never considered as a possible academic or industrial research subject and in urgent need of, at least, preliminary discussion.

When I was invited to give another overview lecture at a seminar on "Human Behaviour during Disasters" at the Australian Counter-Disaster College at Mount Macedon, Victoria, Australia, on 26 April 1984, I chose as my subject "Disaster Research". I published an Editorial about it in my own Journal, *Interdisciplinary Science Reviews* Volume 9, page 193, six months later.

The unique Counter-Disaster College with Brigadier Ian Gilmore Director at the time, who issued my invitation to speak, was established by the Commonwealth of Australia following the Darwin Cyclone disaster of 1974. [See Title 315] Australia, spared earthquakes and volcanoes, often suffers from disastrous bush fires and floods. Regular courses of lectures and seminars on special subjects have trained many Australians in disaster management.

In my lecture I analysed the interdisciplinary nature of any future disaster research and suggested that lack of any academic, industrial or other infrastructural basis for such research explained its absence. I postulated that insurance companies might fund it, as they would have to pay lower indemnities to those who applied the results of appropriate research to their properties. Increasing numbers of disasters, due to the population explosion and other demographic factors, as well as the more frequent location of industry in disaster-prone areas like the North Sea, the Persian and Mexican Golfs, all meant higher loss payments for the insurance industry in the future.

I listed over 20 possible disaster research projects. These examples ranged from prediction and forecasting by analysis of historical and past disasters, the development of a simple scale of disasters, the training and education of people living in disaster areas, triage and other medical aspects, mathematical and other model investigations, to the evaluation of satellite images before, during and after disasters. Finally I paid a tribute to Noah as the first successful research and rescue coordinator, as the lessons of the Ark—analysis, equipment and training—are as valid today as they were in Noah's time.

Only in 1999, a book on the German Railway disaster at Eschede listed lessons learnt during the large rescue. I reviewed it in *ISR* Vol. 24/3, p. 171, 1999

Thanks to Jules Verne Title 83

I had collected Jules Verne's famous *Voyages Extraordinaires* for years in the magnificent *Edition polychrome* and had an almost complete set of over 50 books. Later I had to sell them to the Bryn Mawr College near Philadelphia in order to live. I had even become a member of the French Jules Verne Society and attended their meetings in France: lectures, dinners and visits, I had in fact become a real Jules Verne fan. I was not ignorant of his first book *Cinq semaines en ballon* published in 1863 in Paris, but I never imagined that in 1963 anyone would try and repeat this imaginary voyage across Africa, one hundred years later.

But this was precisely the intention of Anthony Smith, the Science Correspondent of the London *Daily Telegraph.* He had a very good reason to do so, as in Jules Verne's book, the intrepid balloonist was none other than Dr Samuel Ferguson, the Geographical Correspondent of the then greatest London daily newspaper, the *Daily Telegraph*, selling for one penny a copy. Anthony had little difficulty in persuading the owner of the newspaper, Mr Michael Berry, later Lord Hartwell, to subsidise his balloon flight across Africa as a publicity venture for his, in 1963 still the greatest paper in Fleet Street.

But even with all modern facilities at his disposal, it was not easy for Anthony to repeat the Jules Verne voyage — balloons had not become any more dirigible in the 100 year interval and were still at the mercy of the prevailing winds. In the book, Dr Samuel Ferguson had an ingenious small furnace in his gondola, heated by hydrogen and oxygen. The hydrogen of the balloon was to be passed through the furnace to increase its volume and thus the height of the balloon, in order to find favourable winds. This suicidal idea was of course quite inapplicable for Anthony's repeat project, and he had to establish a number of depots of large hydrogen cylinders across Africa, if he had to have any chance to travel across the continent.

He had to have a balloon manufactured in Belgium and pass a 'driving test' for ballooning before he could start from Zanzibar on the east cost of Africa and trust to local winds to carry him westwards as Dr Ferguson had done. However, he did need 'for a few weeks' someone else to write about science in the *Daily Telegraph* and his choice fell on me. As I was just then free of any other commitments, I accepted his suggestion and started as a temporary employee on 13 August 1963. Everyone thought Anthony's project quite impracticable, dangerous in the extreme, and foretold his demise in Africa. Some friends strongly advised me to accept the appointment, as I would not only inherit his job permanently, but would also marry his highly attractive wife, Barbara Smith. Only one of these forecasts came true.

When Jules Verne named in his first book in 1863 as his balloonist Dr Samuel Ferguson, one of the best correspondents of the *Daily Telegraph,* the London newspaper was already famous. Founded in 1855, it had reached a few years later a circulation of 27000 copies, at one penny a copy, only exceeded by *The Times* which, however, cost more. By 1877, the *Telegraph* had a daily circulation of nearly 250000, then the largest in the world.

By the time I joined it, only on a short time basis, its circulation was around 1.3 to 1.5 million copies and still had the reputation as one of the richest and greatest newspapers. This success is widely ascribed to personal ownership, first by the Lawson and then by the Berry families, who had wisely and conservatively guided its fortunes. My temporary appointment was of the simplest kind, a 5-minute talk, nothing else, with the Editor Maurice Green. I only met the owner, Mr Michael Berry, many years later, when I had been well-established as the official Science Correspondent.

Anthony Smith returned from Africa after a few months, not weeks as he had promised, with a large store of excellent animal safari photographs, films and copious notes, all of which gave him many articles and a book, numerous lectures and other sources of income as a recompense for his daring voyage. At one stage a local Reuters agent in Africa reported to London, that his balloon was hit by lightning and going up in flames. “Michaelis write obituary” was the laconic message I received from the News Room, and I promptly followed this command. However, before it could be printed that night another Reuters message was received in Fleet Street “Balloon OK” and his obituary was filed for possible later use in the enormous and well-staffed library. (Many years later I was asked to write my own obituary, as was then the custom for members of the staff, ‘for possible later use’).

My first entry into the imposing marble hall of 135 Fleet Street was more than slightly worrying, as it did not correspond to the dim and hustling newspaper offices I had imagined. I was directed to the 5th floor, where I found the ‘Science Office’ next to that of the Russian Correspondent and other grandiose labels on doors. ‘Science’ was a large and light office with three desks, one for Daily Science, mine, one for Sunday Science and one for the highly efficient Secretary, Mary. The *Sunday Telegraph* Science Correspondent was John Dellin, who left his academic appointment at Loughbrough University on Thursday or Friday to come to London and went home again late on Saturday night. John was a mathematician by academic discipline and a delightful colleague during the 10 years we shared the office.

I had a large table, telephones and an immense wastepaper basket, which always overflowed by the end of the day, such was the vast amount of news that regularly came to me.

Anthony Smith found, on his return from Africa, that he no longer had time for the 'routine' work of a Science Correspondent, and he resigned. Another 5-minute interview for me with the Editor, and on 10 December 1963 I became the now-confirmed Science Correspondent of the *Daily Telegraph*. During my probationary period I had already learnt that the style of writing a newspaper story was quite unlike any previous writing I had done, as for example my Editorials for *Discovery*.

In the best academic tradition I began my reports for the *Telegraph* with a historical survey of the subject, and then after a few paragraphs of background, I started to write about the news item. The result was simply that none of my stories were printed for the next morning's edition of the paper. After a week or so of such failures, I sought advice from the friendly elderly Scotsman who was in charge of the newsroom, the hub of reporters to be assigned to cover the home news for the following day's paper. The news from the rest of the world, 'foreign news', were handled through the Foreign News Editor, Mr Ricky Marsh, an especially delightful and highly efficient journalist-editor.

It was explained to me that the average newspaper reader, to whom after all the contents of the paper was directed, and on whose approval the circulation, and hence the financial success of the *Daily Telegraph* depended, was a gentleman (rarely, and only secondly a lady) who had little time to spare over breakfast or in the commuter train to his office, to read history. He was only interested in the latest news. Hence his attention must be captured, as nearly all readers were ignorant of the news.

If this basic rule of all newspaper reporting was not followed, the reader's eye would jump to another story, or worse still, would throw away the paper and buy another paper the next day and not the *Telegraph*. Only later in the story, any historical background can be given, and can only be printed if enough space is available. "Cut from the back" was the golden rule of the final editors. It was further explained to me that each night, about ten times as much news materials is on offer to the 'Copy taster', the late night final arbiter of what is printed and what is left out. Had these basic principles been explained to me at the beginning of my career in Fleet Street, I would have had an easier start.

Lo and behold, the magic worked, and my first reports appeared in print. I was of course delighted. I can no longer trace of what they consisted, but they were of a minor nature, otherwise Mary would have cut and filed them, a duty she fulfilled meticulously early every morning for all my later articles.

Title 86

Proprietor and Editor-in-Chief of *The Daily Telegraph* from 1954–1987 was Michael Berry, in 1968 created Lord Hartwell of Peterborough in the City of London. *Courtesy Lord Hartwell.*

I soon found out that there was always an alternative to unused stories which had been rejected by the copy taster. The *Daily Telegraph* was administratively divided into two main departments, 'News' and 'Features' with its independent heads of departments, the News Editor and the Feature Editor. What News had been rejected could always be included in my fortnightly Feature "Science and the Citizen" over which I had control. This feature appeared at first monthly, later fortnightly, but I could never persuade Features to give me a weekly full page for science. This is now standard practice for many newspapers, including the *Daily Telegraph*.

I finally decided, after I had worked for the *Daily Telegraph* for a few years, to approach the Owner, Mr Michael Berry, who was after all the Chairman and Editor-in-Chief of the paper. By the time I met him he was in his middle fifties and had his offices on the fourth floor of the Telegraph building. His office was remarkable for the fact that it had a small garden on its balcony. In 1986, he was created Lord Hartwell, a life peer, by Mr Harold Wilson, the Labour Prime Minister. This was a very unusual political honour, as Michael Berry was known to be an arch-conservative and such had always been the policy of his paper.

When he became Lord Hartwell, this was an additional fact why everyone was in fear of him and mentioned his name almost in a whisper. When I received an occasional science news item sent to my office with a note pinned on it saying "Michaelis explain" it was to be treated like a word from the Almighty and it was sure to be printed in the next day's paper with my explanation. I never feared him, I liked and respected him for his great knowledge of science and was therefore optimistic when I approached him for the weekly full page of science. But this was refused for reasons I have never had explained.

Not everyone on the paper got on well with him because of his patriarchal methods and his belief in gerontocracy, as a correspondent put it who had served under him for too many years. He was also known for his tightfistedness, but his belief in the freedom of expression earned him the title as the 'best proprietor of the time'. In 1985, he had, for a number of financial reasons, to sell the newspaper to Conrad Black, a wealthy, powerful and ambitious Canadian, and the editorial offices of the paper soon afterwards moved to an ultra modern and computer controlled atmosphere at Canary Wharf, away from the traditional home of English Newspapers, the famous Fleet Street.

The huge antiquated 19th century printing presses were at the back of the building in Fleet Street, where also the type-setting in hot lead metal was carried out with Linotype machines. The time had come for a change, but it must have been a sad change for Lord Hartwell. He died in April 2001 aged 89. I had left the paper in 1973.

As my work took me out of the office of the *Daily Telegraph* more frequently, it became obvious that I needed an Assistant Science Correspondent if news items of scientific interest from England were to be adequately covered. Much of my absence was abroad, and the Home News Editor, with whom I was never on the best of terms, threatened to have a poster displayed outside the building "Science Correspondent briefly in Fleet Street". I wish he had, I would have treasured it as a great compliment. My principle had always been that the best science stories would not be brought to my desk, but that I had to find them, either somewhere in England or abroad.

An advertisement for my Assistant was therefore placed in the *Daily Telegraph* and quite a number of applications were received from which I compiled a short list for interviews. A standard procedure was applied at each interview and after a preliminary talk about experience, scientific and journalistic qualifications, I told each candidate:

> "There (pointing) in this office is a normal typewriter with paper, there (pointing again) is a clock. You have 10 minutes to write a short story about either the 'First astronaut to land on the Moon is British' or alternatively 'A British submarine has discovered the remnants of Atlantis'. Now start to write it!"

Admittedly a brutal test for any candidate for a new job, but I was convinced that this task was imitating the often extremely harsh conditions in which a science writer for a daily newspaper would have to operate. The resulting stories were compared by the friendly old Scotsman of the News Room and myself. Our judgement was clearly in favour of Clare Dover, and a telegram was immediately dispatched to inform her of the appointment.

Many years later she told me that she was furious about me and the test, and had burst into tears when she left the building. But having read the telegram, she accepted and we worked happily and harmoniously together for many years until she was offered a better position on the *Daily Express* and left. I was right in setting the test as Clare proved time and time again that she could master the most difficult assignments, for example to be the first woman reporter on a British oil rig in the North Sea.

I had little difficulty in finding a replacement. Lord Hartwell called me to his office and asked me if I would accept his son, Adrian Berry, as my assistant. I replied that if he would follow my instructions, I would try him out. We soon became good friends, and his experience of having written best-selling science fiction books and his great enthusiasm for space and astronomy, made our joint reporting of Apollo 11 a real pleasure. [see titles 182 + 183] He succeeded me when I left in 1973.

While Anthony Smith was imitating Jules Verne in Africa with some considerable success, I too as Temporary Acting Science Correspondent was getting used to newspaper writing and had success in getting a good number of science stories into print. Here I can only mention a few to give the flavour of science in the period of 1962 and 1963.

Those were optimistic days for science, with the first halting steps towards the Moon in the USA. Although an unmanned American spacecraft to photograph the Moon, the third *Ranger*, had failed again at the end of January 1962, Col. John Glenn at the age of 40, then considered old, could successfully orbit the Earth three times in his spacecraft *Friendship 7* on 20 February 1962. I was able to forecast six days before the event with five pictures on a whole page of the *Daily Telegraph*, his orbits, the tracking stations and the then biggest use of computers. This was encouraging in deed, both for the American space effort and also for me in getting prominence for science in the paper. Admittedly the Russian cosmonauts Gagarin and Titov had preceded Glenn, and the American astronauts Shepard and Grisom had already made suborbital flights, but this story confirmed Glenn as a real American hero.

My first 'Science and the Citizen' column dealt with the "Little Ice Age" when the Thames froze over in London, and I could announce in January 1962 that the centigrade temperature scale would be used in public forecasts by the British Meteorological Office. My second column dealt with the search for signals from other worlds, and another long article in February 1962 reported the results of the International Geophysical Year, then being published for the first time, three years after its conclusion. Also the eighth nuclear power station in Britain, at Oldbury, Gloucestershire, had been officially cleared to go ahead for design and construction.

Most interesting item in March 1962, was a large picture and my report that in the US Antarctic Base of McMurdo, a small atomic power station was producing 300 kW electricity. At the time, little did I imagine that seven years later, I would be visiting this very atomic station during my stay in the Antarctic. [See Title 199] It was then still working and even producing distilled water, but was shut down in 1970. The most expensive aspect of this whole operation was its transportation to the Antarctic, as every item had to be cut down in size for air transport. The operation of the station itself was considered cheaper than an equivalent diesel electric station, as Admiral Welch, the commander of the base told me during a briefing. The reactor was of the pressurised water type with 93 % enriched uranium 235 as fuel. Excess heat generated was wasted by air cooling.

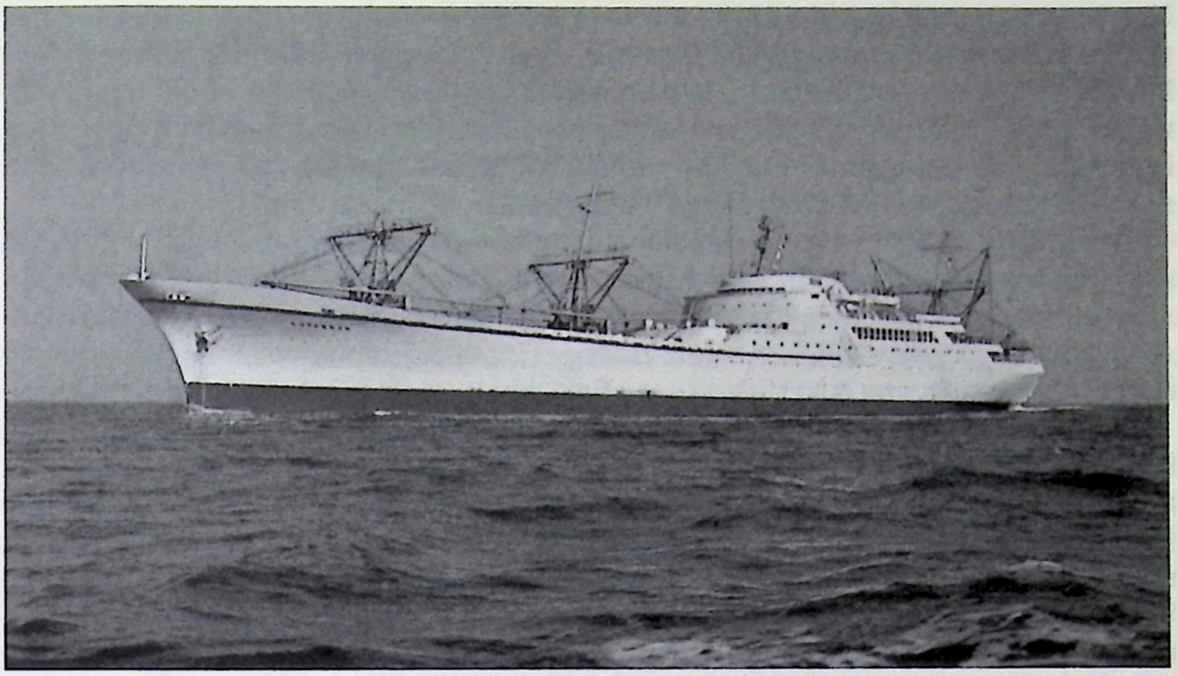
I could not possibly attempt on the following pages to summarise ten years of science reporting, and I shall not try. But I can select from the several thousand stories I wrote during that time, the most interesting travels, the anecdotes, and the occasional, rare, scoop. When essential, I kept a daily, even hourly record, as during the Apollo space flights. Some entries I wrote in longhand during an interview, some I typed on my small portable Hermes typewriter, and then transmitted them back to the *Daily Telegraph* in London by telephone, Telex, only much later by FAX, but most frequently by telegram.

Each item of work, whether pubished or not, was recorded by date, based on the Swedish National Insurance system which simply allocated as registration number to each person, a number none would ever forget, the date of his or her birth. This number was composed of year, followed by month, followed by day, as it would increase each day by the figure '1' and would repeat only after a century. So for example, 970319 signifies today, 19 March 1997. Such a six-figure number was written, or typed for 10 years by me on each of my standard 15 × 21 cm sheets, A 5, easily bought as blocks. The use of these numbers worked exceedingly well and when later bound together as a book, the consecutive numbers acted both as dates and as page number. I have recommended them to friends who were also pleased.

I started as the Science Correspondent of the *Daily Telegraph* on 10 December 1963 and did not have to wait long before on 4 January 1964 I was sent to the USA to report on the preparations for the forthcoming flight to the Moon. "Building spaceport USA" was the formal title of the gigantic operations at Merritt Island in Florida, just inland from the actual launch site.

In charge of all this was the US Army Corps of Engineers, famous for having built the Panama Canal, which Lesseps of Suez Canal fame, failed to achieve. The first step was to purchase 130 square miles of waste land in Florida, called Merritt Island, at a cost of US$ 60 million. It was built up by dredging the Banana River, pumps sucking up the sand from the bottom of the river, and then it was hard-compacted. By the time I visited it for the first time, piles had been driven into the compacted sand, and the foundations had been laid at a cost of $ 8 millions, as W.T. Clearman, the Chief of the *Saturn* Construction Office, informed me on my press visit on 27 January 1964.

I saw from my VIP one-hour-long helicopter tour in the brilliant Florida Sun a vast complex of white industrial buildings, radio and rotating radar antennae, block houses, a spaghetti of roads, rail tracks and canals, which alone were able to bring to Florida the giant rockets on special barges. The VAB, the Vertical Assembly Building, for final upright assembly of the Saturn rockets was beginning to be built. I was most impressed, became enthusiastic about the Apollo Moon Program, and sent voluminous reports and many photographs to London. A selection was published.



Title 90

In June 1964, the NS Savannah, the first nuclear powered merchant ship, sailed on her transatlantic maiden voyage from New York to Bremerhaven, and I was able to join her in the Straits of Dover. On this historic voyage she was accompanied by the dreams of marine engineers that a new age of ship propulsion had dawned through the ideal energy source of atomic fission, but atomophobia prevented her from visiting any foreign ports. She had a displacement of 21 850 ton, a cruising speed of 21 knots, accommodation for 60 passengers and needed refuelling only every 3 1/2 years. *Courtesy NS Savannah.*

My first Scoop: Nuclear Ship Maiden Voyage — Title 90

The American nuclear ship *NS Savannah* left New York on 6 June 1964 for her transatlantic maiden voyage, and I had received a message to this effect. A few days later, through the excellent telephone operators of the *Daily Telegraph*, I could talk to her Captain, David McMichael, while in Mid-Atlantic, and I asked him to stop in the English Channel off Dover for a few minutes so that I could come aboard to cover her successful maiden voyage. He agreed.

She was the first, and has so far remained the only, nuclear passenger and cargo ship to cross the Atlantic, capable of carrying 60 passengers and 10000 tons of cargo as a full load, displacement 21850 tons. She was a joint project of the US Maritime Administration and the US Atomic Energy Commission and was named after an earlier *Savannah,* which in 1819 was the first ship to cross the Atlantic under steam.

When I saw the slim outlines of the nuclear ship approaching, coming out of the mists of the English Channel, I was in a small motor boat with a photographer from the newspaper, but I had no idea if she would stop for us at the arranged rendezvous 3 miles off the coast of Dover. She did, and we went on board to be most hospitably received as the first European representatives of the Press. She was bound for Bremerhaven in Germany, then the central port for all supplies to the American troops stationed in Germany.

She was most luxuriously equipped for a merchant vessel, being an example of the peaceful uses of atomic energy and the American bid for naval supremacy in the Nuclear Age. I had the free run of the ship, interviewed the Chief Engineer, obtained full technical data of the pressurised water reactor, all safety precautions to prevent atomic radiation and could that day radio my story back to London which appeared in the paper the next day, 17 June, under the headline "Across the Atlantic on 1¼ lb of enriched uranium".

She was a proud ship and everyone on board, including myself, thought that nuclear propulsion would be the future power supply of all ships. In Bremerhaven we were received by the world's press which I had scooped by one day. That the *Savannah* could not call at any other port and was broken up on her return to the USA was entirely due to political pressure from environmentalists who feared radiation and atomic pollution. For me it was the first sign of the shape of things to come, of anti-science and anti-technology sentiments and succesful reactionary action. No Scientific Temper.

I must add a personal postscript: The London *Daily Express* newspaper on 17 June had the following note: "The *Savannah* developed a fault in the English Channel and had to halt three miles off Dover while a specialist technician [SIC!] went on board. She came no nearer for fear of radiation and later made for Bremerhaven."

Atomic Mega Show in Geneva Title 91

It was less than two months later, in August 1964, that I had another opportunity to indulge in atomic optimism, namely, at the third United Nations Conference on the "Peaceful Uses of Atomic Energy". There was no anti-science or anti-technological sentiment in Geneva, where the First of these Mammoth Conferences (15 volumes of proceedings) had taken place in 1955, followed three years later with the Second (2300 scientific papers producing 34 volumes). The First led to a removal of secrecy about Atomic Fission and the second openly discussed for the first time Atomic Fusion research in the Soviet Union, in Europe and in the USA.

The Third Conference was called "Big Reactors—Big Business" by the assembled world press even before its opening by U Thant, the Secretary-General of the United Nations. They alone were capable of organising such an international monster assembly of 3000 industrial, Government and academic scientists and engineers. With money no object, hotel suites and whole floors had been booked months ahead by the representatives from 71 countries, all anxious to benefit from this mega show of "Atoms for Peace". Huge exhibition halls showed models of all kinds of atomic reactors and their components, for the first time, ready 'for sale'!

All possible uses of atomic energy were either displayed as exhibits or fully discussed at various seminars or exhaustively advertised at the many press conferences given by industrial and governmental sponsors. Equally spoilt by the ultra-rich purchasers of atomic electricity stations were the science correspondents from all well-known newspapers with invitations to parties, lunches and dinners at Geneva's best and most expensive restaurants. The atom was certainly then the 'best friend' of the press.

It was not difficult to report about these atomic halcyon days for the *Daily Telegraph*. Being an extremely conservative, almost chauvinistic newspaper, my obvious priority was to file about the 77-strong British delegation, led by Sir William Penney. All my stories were promptly published the next day. 'Costs of A-Power Plant falling, says Penney', 'Britain hopes to double nuclear Production—Penney's forecast for 1970', 'Reactors: A Choice for Britain' were the headlines for my major articles.

My minor contributions from Geneva, so my records show, were 'U.S. Reactor Race with Russia' and 'Nasser wants Nuclear Power Plant—Invitation for Tenders'. But for me the most interesting uses for nuclear energy were not atomic electricity stations, but other engineering uses.

Having just been on a voyage aboard the Nuclear Ship *Savannah,* I was of course most interested in the proceedings dealing with other nuclear ships. The first ever atomic ship propulsion was in the U.S. Navy Submarine *Nautilus*, operational since 1955 and world-famous in 1958 for crossing submerged below the North Polar Ice. I was so enthusiastic about this achievement that I decided to present a copy of Jules Verne's original French first edition "*Vingt Milles Lieues Sous Les Mers*" to the submarine's captain, Commander William R. Anderson. [See picture Title 67]

Jules Verne's submarine, the original *Nautilus* under the command of Captain Nemo, reached the South Pole submerged in his classic book, published 1870. On my next visit to Paris I found a copy and I could now approach the U.S. Naval Attaché in London, Rear Admiral R.W. Cavenagh, and at a small ceremony at US Navy HQ, Grosvenor Square in London, he accepted the book for onward transmission to the USS *Nautilus.* In return I received from Commander Anderson a copy of his book in which he described his passage under the North Pole.

But to return to Geneva. At a Soviet press conference, A.M. Petrosyants, the Chairman of the State Commission for the Utilisation of Atomic Energy in the USSR, praised the nuclear performance of the Icebreaker *Lenin,* commissioned 1959, which had completed 63000 nautical miles, two thirds in Arctic ice fields. He announced that two further nuclear propelled icebreakers were being built. (The *Antarktika* was launched 1973 and the *Sibir* in 1976). My report about the press conference appeared next day under the heading: "Russians plan two more Atom Icebreakers".

The German nuclear propelled ore carrier *Otto Hahn* was launched at the time of the Geneva Conference in 1964 and had by 1975 completed 380000 nautical miles without any accident. Similarly the NS *Savannah* launched 1962 had by 1975 completed 575000 nautical miles. At the time of the Conference it was estimated that at least 180 naval units, mostly submarines and aircraft carriers, were nuclear power propelled. They were in the service of the United States, the USSR, the British and the French navies.

It only remains to mention the Japanese vessel, the only other nuclear propelled merchant vessel, the *Mutsu* launched in 1969 and commissioned in 1972. She was unlucky, and her reactor leaked during a trial voyage in 1974 but could not immediately be repaired.

Thus ended one dream of the peaceful uses of atomic energy, simply because these merchant ships could not enter—to them—foreign ports as anti-nuclear hysteria created by the fear of environmentalists was too great. [See also Hans Michaelis, *Kernenergie*, DTV, Munich 1977]

"Operation Plowshare", the civil engineering applications of atomic bombs, was fully described at the United Nations Conference for Peaceful Uses of Atomic Energy by two American scientists, Dr Gerald W. Johnson and Garry H. Higgins, of the Lawrence Radiation Laboratory in California. 'Plowshare' was the second great dream of atomic scientists that would prove to be an illusion, never to come true. If the panic was effective to forbid nuclear propelled ships to enter foreign ports through environmental pressure by fearful politicians, how much greater would be the atomophobia for bombs exploded in the countryside for simple engineering projects? Such logical deductions of 'atomophobia' were not discussed at Geneva.

Plans for Operation Plowshare were well advanced and even costs were for the first time fully released by Johnson and Higgins. 'Project Carryall' was a plan to use atomic bombs to blast two ditches through the Bristol Mountains in California for railway tracks and motor ways. The ditches were to be 3.2 km long, 100 m wide and 100 m deep, 22 bombs would be used, producing an equivalent explosive force of 1.73 million tons TNT. The US Atomic Energy Authority estimated £ 125 000 for a 10000 ton bomb and £ 210000 for a 2 million ton bomb. Workmen could resume their activities after one week and residents in nearby areas would be evacuated, but could return after one year with complete safety, it was stated. These figures were based on long experience with American underground atomic bomb tests in Nevada.

Plowshare had also been considered for a second Panama Canal, and Johnson and Higgins reported that the US House of Representatives had approved a feasibility study only a few days before the Geneva Conference. They had allowed 5 years for a survey, 2 years for blasting and 2 years for clean-up operations.

Another application of Plowshare was discussed at Geneva, a 100 km long canal from the Mediterranean to the Qatarra Depression in north-west Egypt, lying below sea level. First proposed and surveyed by a British engineer G. Ball in 1925, such a canal would produce hydro-electricity and create a large inland lake. Its evaporation in the desert Sun was projected to create clouds, which in turn were to produce rain and thus open large desert areas for agriculture. This project was urged by M. Hedayat, the United Arab Republic's Minister for Science, who stated that his engineers had already made extensive preliminary surveys.

I was glad that a day later I could file a report to London that Francis Perrin, the High Commissioner of the French Atomic Authority, had offered to provide atomic explosives to Egypt for the Qatarra Canal, but that he preferred to do this through a new International Authority. Another dream!

Nuclear Desalination and Gaza Politics Title 94

A giant nuclear desalination plant, producing 4.5 million cubic meter a day of fresh water from the sea and 2 Megawatt of electricity, this was the ultimate aim of the US Atomic Energy Authority, as reported at the Geneva Conference by James Ramey, one of its Commissioners. Already in 1964, the year of the Conference, the need for additional fresh water in many parts of the Earth had become an urgent necessity, and this need has in the following decades become ever more imperative.

An ample supply of fresh water is the critical factor for an ever increasing human population, for irrigation and for greater industrialisation in many underdeveloped countries, as well as in certain areas of the developed world. For example Southern California, Australia, Israel, Tunisia, Spain and Greece and even Essex County in Britain, would all welcome more fresh water. One day perhaps will Politicians, yielding to population pressure, override environmentalists' opposition, and learn the Scientific Temper?

Where energy is cheap, as in the oil-rich States of the Persian Gulf, desalination is a cheap routine operation by simple distillation in vacuum using the flash process. Nuclear desalination would be more expensive, it was admitted by the speakers at the special session devoted to this subject in Geneva, but no figures were given, as many variables enter into the cost calculations.

So for example Dr F.S. Aschner of Israel's Institute of Technology in Haifa, stated that their large Transac Computer had been used for cost and efficiency calculations. He informed the Session that in June 1964 American experts had visited Israel to study the technical and economic aspects of nuclear desalination. In July 1964, a Russian team of experts visited Washington at the invitation of President Johnson for discussions on this subject, as apparently the USSR was the only country which had built a nuclear desalination and electric power station.

There was no public mention of the political consequences of a nuclear desalination station in Israel or its occupied territories. After several visits to Israel by myself in the following years, it struck me that if such a station, with American aid, safety knowledge and know-how, could be built in the Gaza Strip, it could also provide a political solution to the Israel-Palestinian conflict. If ample fresh water were available in Gaza, at present a desert-like area, a rich fertile land could be created and, with Israeli experience of desert reclamation, the irrigated areas would become a highly desirable home for the then widely scattered Palestinian refugees.

Such a political conflict might well be settled by modern high technology. I discussed my idea with both Israeli and Egyptian scientists and urged them to approach their politicians to start at least discussions on this subject. But it remained just one more dream.

Only three weeks after my return from Geneva I had an invitation to one of the prestigious Ciba Symposia, the 85th, and the first to be held in conjunction with an Ethiopian Foundation, in Adis Abeba. It was also unique that I received an invitation as a member of the press to one of these usually private Symposia. [See Title 97]

After six months as Science Correspondent, a certain routine had developed in spite of the daily new aspects of science which I had to report, explain and comment for the general public, the readership of the newspaper I served. I arrived at my office at about 10 o'clock, a very early hour for most journalists, coming by Landrover from my flat in Hanover Terrace. Daily parking was then no difficulty in a multistorey park house and very cheap.

I found on my desk not only the normal mail, but already many other news items which had arrived overnight by telegram from abroad.They came from the great news agencies to which the *Daily Telegraph* subscribed. Apart from the standard English ones, like Reuters and Associated Press, there were the American and Commonwealth Agencies whose items, in the opinion of the Foreign Editor and his staff, were of scientific merit. Not all were important and many ended in my huge wastepaper basket, 1 m high and 50 cm diameter.

I also received a large number of press releases from industry and government organisations who thought that they might be publishable by a science correspondent. Later on, the European Universities, following the American example, also issued their quota of news releases, which I often found really worthwhile. It was a daily chore to sort them all out, and to evaluate the invitations which I received to press conferences and press visits. If it was a notice of a scientific conference I received, and I thought it might yield interesting material for the newspaper, I would just attend it, if it was in London or England. I would of course inform the News Editor of this fact and warn him that there might be a story for next day's paper.

If the conference took place abroad, and travel expenses were involved, I would discuss it with the Foreign Editor, Mr Ricky Marsh, and he would either give, or withhold, his blessing. Expenses were always submitted on a weekly basis and paid in cash, as the sums were relatively small. For entertainment at my Club, the Savile Club, there was never any question of whom I entertained. They were invariably scientists from whom I either hoped to receive information immediately, or possibly later, in which case he, never she, would be classed as a 'contact', a much used expression by all journalists for the justification of a lunch. I doubt if this has changed.

It may be of interest to record here in chronological order the titles of some stories published and some, written but not printed, which I worked on during my first year, 1964, at the *Daily Telegraph*. Should a bona fide research worker consider any of these titles of sufficient historical interest, I shall try to make a copy available from my archives.

COUSTEAU AT ROYAL GEOGRAPHICAL SOCIETY
WYLFA NUCLEAR POWER STATION
DELTA PLAN TO SAVE HOLLAND FROM FLOODS
CHEMICAL AND BIOLOGICAL WARFARE—VISIT TO PORTON
ANTI—LEPROSY DRUGS—RESEARCH AT MILL HILL

CERN—VISIT TO GENEVA
POST OFFICE TOWER IN LONDON
H.G.WELLS' FILM 'FIRST MAN ON THE MOON' REVIEWED
SYNCOM III AND TOKYO
BRITISH ASSOCIATION MEETING IN SOUTHAMPTON

ABU SIMBEL—PARIS
RUSSIAN DOOMSDAY MACHINE
RUSSIAN FUSION ADVANCE
BRITISH ANTARCTIC SURVEY
ROCKET RACE TO MARS

CHINA'S ATOM BOMB
BRITISH 'BLUE STREAK' ROCKET
STRONTIUM 90 IN CHILDREN'S BONES DOUBLES
RUSSIAN NON-MAGNETIC SHIP IN LONDON
ELECTRIC LIGHT WALL PAPER

HIGHEST FALL-OUT OVER LONDON IN 1963
QUEEN ELIZABETH OBSERVATORY IN CANADA
BRITAIN MAKES PLUTONIUM FOR FRANCE
ROYAL SOCIETY WIDENS HONOURS
RADAR THROUGH ICE

CHRISTMAS SCIENCE LECTURES IN LONDON
J.B.S. HALDANE OBITUARY
SCOTT POLAR INSTITUTE WANTS SHIPS LOG
TIME ON MOON
FRED HOYLE ON QUASARS

CIBA's 'Man and Africa' in Adis Abeba Title 97

Ethiopia's capital, Adis Abeba, was founded in 1887 and named „New Flower"by the Empress Taitu. When I arrived by Ethiopian Airlines in 1964 for the Ciba Symposium, there was one new magnificent building in which our symposium was held, but otherwise none of the housing, vehicles and streets, were neither new nor did they resemble a flower. I was disappointed.

More than 30 distinguished scientists, engineers and medical men had been invited by Ciba from Africa, India, Europe and the USA.The concept of the Symposium was to consider Africa as a unit, as a continent without political borders, and to explore during a week of private discussions, how science and medicine could improve by the year 2000 the generally acknowledged primitive conditions of most of the African Continent. It was an imaginative attempt to introduce the Scientific Temper, through an interdisciplinary discussion, to a country in great need of it.

This grand concept was due to Dr Gordon Wolstenholme, the Director of the Ciba Foundation in London. He was also responsible for the establishment of the Haile Selassi Foundation in Adis Abeba, named after the Emperor who had in the previous year, 1963, played a major part in the creation of the Organisation of African Unity and in bringing his country into the modern world. The concept of this Ciba Symposium was inspired by him, and he gave a magnificent reception in his Palace for the participants.

But was it just another dream? When the Africa of 2000 is considered with its horrific tribal warfare and its examples of genocide, the continent is just as far away from a political unity with Scientific Temper as it was in 1964. Naturally I watched scientific progress closely during some of the intervening period and could only report a few isolated instances in agriculture. Neither South Africa nor Algeria were represented at the Symposium.

A welcoming address by the Ethiopian Prime Minister transmitted the good wishes of the Emperor. The Symposium was held in the Africa Hall and began with perhaps the most important problem, Africa's human population. But lack of reliable statistics made discussions difficult. Racial, tribal and religious differences were not easier to solve then, as now in 2000 AD. Mental health, in Africa an almost completely neglected aspect of health, epidemiology, water resources, agricultural potentialities, the conservation of natural resources—African minerals only mined since about 1910—economic and industrial growth, and electronic communications—all these subjects were reviewed, but most expert speakers regretted the absence of sufficient basic data. Everyone urged that these must be provided on a priority basis and that the desperate planning needs could then be considered by politicians and implemented as soon as possible.

I have always made it a principle when visiting a foreign country to cover as many scientific aspects as possible. In Ethiopia I was able to visit, before the beginning of the Ciba symposium, a modern scientifically planned cotton plantation, about 300 km from Adis Abeba. To reach it I had to hire a small plane with a pilot, who could barely reach the necessary height to cross an intervening mountain range. All went well and I wrote a story about the British enterprise in the plantation and had the pleasure of seeing it in print. The expense was never queried.

Transmitting my reports back to London is normally easy, but not so in Ethiopia, where new Telex facilities existed, but no operators yet. Before leaving London, I therefore took some lessons in the Telex-room of the *Daily Telegraph,* and as these were not more difficult than typing on a basic mechanical typewriter, my copy got through.

The return flight from Ethiopia took me necessarily over North Africa, and I knew of the oil prospecting and drilling operations in Libya by British Petroleum. Before leaving London, I had therefore contacted the Chief Press Officer of the Company and obtained an invitation to visit them in the Libyan Desert. Without their active help and support for all my essential facilities, I could never have seen and reported about one of the most scientific mining technologies anywhere, let alone in a desert, where every piece of equipment, every drop of drinking water and morsel of food, had to be flown in or trucked over hundreds of kilometers. I flew from Adis via Athens to Benghazi, the headquarters of the local BP, where I was briefed.

Having worked in the research laboratory of an oil refinery during the war, [see Title 25] I was of course familiar with the theory of oil exploration and drilling techniques, but thrilled to see them in practice at the U1 Oil Exploration Camp in the Libyan desert. I lived for a few days with the scientists and engineers in their air-conditioned mobile homes and thoroughly enjoyed their explanations and demonstrations of 'seismic shooting' to determine possible oil strata. Even more fascinating were their analyses of the reflections from the underground rocks, caused by setting off miniature explosive charges on the surface.

But however careful and precise the analysis, the true existence of oil must be confirmed by actual trial drilling before the huge production drills are transported into the desert and operated there. I was shown all this and was able to report back to London, where my story appeared under the headline "Every Third Week Off for Oil Drillers".

Alone in Libyan Desert — Title 99

During the four days I spent in the Oil Exploration Camp in the Libyan Desert, I enjoyed complete freedom and was given a Landrover to drive to any site I wanted to see. I was warned, however, never to lose sight of the drill towers, as otherwise one would be hopelessly lost, and an expensive helicopter search would have to be organised. The area around the camp lay in the middle of a battlefield of World War II, and hundreds of tanks had left their tracks, crisscrossing each other and utterly confusing all subsequent drivers over the area. My records show that at 09.00 hours on 10 October 1964, I wrote the following in my note book:

> „In front 180° flat desert, above 180° blue sky, behind the green Landrover, my 20th century technological camel. The black line, the road of a few days, never to become a highway, leading from the old oil rig, beginning at a vertical hole 3000 m deep to the new one, another vertical hole 3000 m deep. Man's short stay of a few weeks at either end. Nothing more.
>
> The wind howls gently through the Landrover behind me, a fly from nowhere has joined me, the Sun is getting warm. The black line crosses another line, the old Italian road from Tobruck to Kufrah, about 25 km west from here. Built 30 years ago, all that remains are the tracks of the vehicles and the sand-blasted black signposts. No name, no paint has remained.
>
> The surface of the desert here is smallest gravel, one stone thick, and the sand below. And gravel from here, the centre, to the 180° semicircle that meets the blue sky at the horizon. Nothing moves in the desert. Different from the sea, where the waves are in constant motion and the boat must be omnipresent. And the shimmering heat in the distant sand, looking like water, is only a cruel illusion.
>
> In the desert the Landrover is behind me, small and still, there is no sound except the wind and I am alone with gravel and sand and the sky, and above all, the Sun. The Sun that gives man his life, his plants and his food, his warmth and his energy, gives here in the desert only intense light and scorching heat.
>
> And yet, 50 m below me, there is fossil water, pure and plentiful, but without finding it, man could not come here to make the mud to drill for oil, to live and work. Nothing moves here.
>
> And the dead camels I saw on my way, white bleached bones, perfectly preserved skins and furs and eyeballs below. And the folds of my skin, moist, sweating in the hot Sun. I am alone with my thoughts Nothing moves in the stillness of the desert.
>
> And it is 09.40, I return to the Landrover and back to the Noise and the Now, the oil camp."

Libyan Desert This was the first desert I ever saw and I loved it, the solitude, the stillness and the infinity of vision to the horizon. I was lucky that I could drive right into it with my own car and stop to flavour it and I have described my feelings [see Title 99]. Geographically it is in Cyrenaica, and as the precise location of the BP oil camp is a trade secret of the company, I never asked for its longitude and latitude, perhaps it was 600-800 km south of Benghazi, about 1200 km west of Cairo.

Namib Desert During my visit in February 1969 to the Republic of South Africa, I had heard of the Namib Desert research station and I asked to see it [see Title 175]. I flew 1200 km north from Cape Town to Windhoek, 300 km west to Swakopsmund on the coast of the Atlantic Ocean and onto Walvis Bay, and from there about 100 km south to Gobabeb, the station. The name means "The Place where there is nothing". I had an official 'minder' to drive the Landrover, but soon found he had no experience and I took over. It was sandy ground, a track along a dried river bed and no danger of losing the way. Further south from the station, enormous sand dunes extend from the coast far inland, the largest dunes in the world. The only maps of these were satellite photographs from NASA. I was never alone there and found the research most interesting, made ample notes and wrote about it. This was published under the headline "Across Africa's Texas by Satellite Map".

Negev Desert I had a chance of driving a few times across this desert area in the south of Israel on either the 200 km old road, or the new military highway between Beersheba in the north, and Eilat on the Gulf of Aqaba in the south. Both roads were in excellent condition, tarred and signposted both in Hebrew and in English. As only few people use the old road nowadays, a breakdown may mean waiting for a few hours before another car comes along. Basic desert precautions apply of course, ample spare drinking water and never to leave the car in case of a breakdown, as walking for any length of time in the desert heat soon leads to exhaustion and collapse. In Israel I always hired a large reliable Volvo, took some water and never had any trouble.

The old road, built by military engineers soon after Israel's independence in 1948 is only one track wide, and halfway between Beersheba and Eilat comes to Mitzpe Ramon, an enormous escarpment from which there are breath-taking views. The road winds down in steep zig-zag fashion on the other side and one comes into flat rock strewn desert. Rumour has it that Israel's secret atomic reactor is hidden inside the escarpment at Dimona. [See Title 26] As I often drove alone, I could stop where I wanted, and I made numerous watercolour sketches of the desert, some beautiful memories for me.

Undoubtedly the most interesting desert I crossed was the Nullarbor Plain in the Centre of Australia. *Nullus arbor* = No tree, accurately describes this vast 1/4 million square kilometer limestone and dolomite plateau, 650 km from east to west and 400 km from south to north. It was first crossed in 1841 by the British colonial administrator, John Eyre. Flat, covered with small stones, the only vegetation is salt bush and blue bush, less than 1 m high.

There are no human habitations in the Nullarbor, and without the Transcontinental Railway, built 1912-1917, only a telegraph line and the recent Eyre Highway, join the East of Australia with its West. The construction of the railway line was as heroic an enterprise as that of the Suez Canal and of equal importance for political, economic and strategic reasons. Politically it was the first great work of the Australian Federation (now Commonwealth) founded in 1901, and for strategic reasons Kitchener pointed out that without an east-west link no defence of the Continent would be possible. David Burke has written an excellent account *Road through the Wilderness* (NSW University Press, 1991) of the building of this vital rail line against all obstructions, by man or by nature. The railway has the longest stretch of straight railroad track in the world, 475 km, which runs without any curve east—west.

I was fortunate to cross the Nullarbor in the days when locomotion was by steam and not by modern diesel-electric air-conditioned trains. It was winter time, the temperatures moderate, and my wife and I could experience the anachronism of having to change trains, because different gauges existed then in Victoria, on the Transcontinental and in West Australia. Between Melbourne and Perth, watches had to be changed twice, for two time zones.

Because coal and water had to replenished frequently for the locomotives, depots were established about every 50 km, and our train stopped at many of these. Most had aboriginal names, like Woocalla (crow), Coondambo (Kangaroo rat), Ooldea (meeting place with water) and Naretha (salt) to give a few examples. At one depot an aboriginal came close to our window and seeing me, burst out laughing, pointing to my moustache which was apparently new to him. It took three days and four nights from Melbourne to Perth.

The most astonishing observation was the glistening path on both sides of the rail track which accompanied our journey. I got out at one depot and found nothing else than thousands and thousands of broken beer bottles, thrown out of the windows. What will archaeologists say, in a thousand years, when they discover hundreds of kilometers of these straight east-west lines of silicone glass when rails and wooden sleepers had disappeared long ago? Perhaps their speculations will dwell on guide paths for Sun-worshippers?

See also Woomera Title 132.

Mojave Desert In search of the most futuristic science story, the nuclear rocket engine for space flight, I found it 150 km north of Las Vegas and 500 km east of Los Angeles in California. I travelled there on 4 August 1969, having received security clearance from both NASA and AEA. It was an easy drive in a hired Hertz car, and I was expected to take only one hour on a super highway to reach Jack Ass Flat, the nuclear research station in the desert. It was real desert heat when I got there, completely dry and 46 °C in the shade, being only a few kilometers away from the Nevada Underground Atomic Bomb Test Site of the Atomic Energy Authority. The nuclear rocket test engineers told me that when an underground bomb test is in progress, they have to halt all their own experiments "so violent are the earthquakes".

For any lengthy manned space flights inside our own solar system, the presently used chemical rocket engines, burning liquid hydrogen with liquid oxygen, are totally inefficient and inadequate. The alternative is to pump liquid hydrogen at a temperature of – 270 °C through an Uranium 235 reactor at a rate of 7 ton a minute, producing a stream of hydrogen at more than 2500°C. This record had been achieved at Jack Ass Flat a year before my visit, with a Phoebus 2 engine, its power output being 4500 megawatt for 12 minutes, out of a total run of 32 minutes.

"At that level it became the world's most powerful atomic reactor that had so far gone critical and worked" Mr John Jewitt told me proudly. He was at the time the Chief S.N.P.O. – Nevada, the Chief of Space Nuclear Power Operations in Nevada. I wrote in my report, filed to London and there set in print, but never published: "There is nothing like it in Europe. Any Russian efforts in this field, although shrouded in secrecy, are unlikely to be any match to the American progress, if recent Russian space endeavours are any guide." (On 21 July 1969, only two weeks earlier, Armstrong and Aldrin had landed as the first astronauts at Tranquility Bay on the Moon.) [See Title 214, later article published]

There could be no doubt whatsoever that NASA and the AEA were most seriously working on nuclear propulsion for space flight, but never for the first stage of departure. This would always be achieved with chemical fuels to launch the spacecraft beyond the Earth's atmosphere to avoid all atomic pollution. Only then, nuclear engines would take over to complete the voyage to Mars and beyond. By the time I visited this most remarkable desert establishment the engineers explained to me that during the last 15 years about one thousand million US Dollar had been spent, and that the same amount would be needed during the next seven years to complete their research work. This was never done, atomophobia stopped it all.

See Watercolour Title 102, inside Front Cover

Sahara, Colomb Béchar The Americans are by no means the only ones using deserts for secret research projects connected with defence. When atomic bombs were tested on the surface, deserts were invariably chosen, but I never saw this, nor did I write any reports about them. However in 1960, before joining the *Daily Telegraph*, I was invited by the French Government to report on science in Algeria and on that occasion was taken to Colomb Béchar, a small railway terminal linking it with Oran and Nemours on the Mediterranean coast.

In 1947 the French Army and Air Force established a missile testing range at Hammaguir, about 100 km to the south-west of Colomb Béchar in the Sahara where the weather conditions were equivalent to Jack Ass Flat, but with sandstorms of up to 150 km/hour. Our group of British science writers were treated to a night rocket launch, very impressive, but it revealed nothing technically. We slept the nights during this week-long visit in the barracks of the French Foreign Legion, and I remember being impressed with the electric sockets in the washrooms for electric razors [seeTitle 64].

Woomera—Australia In March 1966 I had an invitation to visit another desert missile range, this time in the middle of Australia, jointly established in 1946 by the British and the Australian Governments. During these 20 years a small town had grown up in this area, with bungalows for the women and children of the engineers working on the range, with an Olympic swimming pool and with a supermarket. However, I reported to the *Daily Telegraph* that "Woomera was a sad sight" when compared with American achievements. Technically the equipment had neither been updated nor extended during the last decades, and only small scientific rockets had been launched. However, failing any political or financial support from the two Governments, no large and modern missiles had been developed [see also Title 132].

Sonoran Desert—Arizona This beautiful desert was shown to me by a scientific friend, Professor Charles (Chuck) Sonnett, whom I visited in Tucson. We drove in his car a few hours and then I saw the most magnificent Saguaro cacti, up to 10 m or even higher, with their 5 or 6, or more branches, coming out of their green ribbed columnar tree-like stands. I was told remarkable facts about them, that they bloom for the first time after 50 years and that they can be up to 200 years old. It was pure nature, without man's weaponry.

Antarctic Continent I saw this, the greatest desert of all, on my flight from the American Base of McMurdo to the South Pole. Below us the endless white ice, above us the pale blue sky, we crossed effortlessly the Beardmore Glacier, which had demanded such a super-human effort from Captain Scott to overcome [Title 195].

The Mesoscaphe Submarine and Radar through Ice Title 104

The first tourist submarine was built for the Swiss National Exhibition in Lausanne in July 1964. The designer and constructor was Jacques Piccard, the son of the world-famous Swiss Physicist Auguste Piccard who had reached the stratosphere in a giant balloon and then later descended to the ocean floor in a similar vehicle, but with his 'balloon' filled with petrol. He called it a 'Bathyscaphe'. Being on a private visit to Geneva, a few kilometers from Lausanne, I drove over to try and obtain a story for my newspaper from a ride in the Mesoscaphe, named *Auguste Piccard.*

I did make notes, as my press pass got me a free ride. It was quite dramatic but the story was never printed. It had 40 seats, 3 pilots and a hostess, and above each seat was a television screen, but no heating or air-conditioning for the short dives–mine lasted from 12.50 to 13.26, 36 minutes. Next to my seat was a small porthole, just large enough to have a good view of the water outside. One of the pilots gave a running commentary, mostly about water temperature, depth, and velocity through the water, which electrically driven, reached a maximum of 11 knots.

I kept careful records minute by minute, but the view was completely 'nothing'. One heard a slight humming of electric motors and after 5 minutes the TV screen went blank and drops of water, condensation, began to fall from the steel ceiling. The colour of the water changed from green to grey, and 3 minutes later, we reached a depth of 20 meters. After 11 minutes diving, we touched the bottom of the Lac de Genève at 62 meters, water temperature being there 5 °C. We had seen nothing except air bubbles, no sign of life. Then after 18 minutes one small fish, about 5 cm long appeared, and that was all. It was the 18th cruise dive of the Mesoscaphe and I never heard of it again, nor whether if it was ever used elsewhere for sight-seeing or tourism [but see Title 185].

One of the last reports of 1964 was an invention of Stanley Evans of the Scott Polar Research Institute in Cambridge. I went to see him in December, and he explained to me that radar signals sent vertically down through ice would be reflected back twice, once from the bottom below, and secondly from the surface of the ice. The difference between these two times, the two reflections, would give an exact thickness of the ice. It had a successful test during the summer on the ice cover of Greenland, 1.5 km deep. Slightly larger than a car radio and battery operated, its total research and development cost was only £ 6000. Its great advance, over the previously employed seismic sounding, is the continuous record of depth as the radar was driven across the ice in a tracked vehicle, and it was hoped one day to fly it over the Antarctic. Five years later I took part in these first tests [Title 201].

Our better Future—"I believe" Title 105

Having worked one year as Science Correspondent, I found that a few lines I had written in the past were fully justified. I had my cynicism confirmed, but I was, and still am today, full of hope for the future.

I BELIEVE

Love and Reason and Hunger
The forward Forces
Guiding the Spirit of Man
From the Cave to here and now
And his future?

Love and Art and Music
The Word and the Moving Picture
Inspired by Woman
Created by Man
From Dreams came Peace and Beauty.

Nature looked on
Unmoved
Time's infinite Flow
The Depths of Space
And Man: —What, when and where?

Alone on his Speck of Dust
His Earth
He killed and destroyed
Created and lived
His Future his own now to shape.

Power and Knowledge and Science
God gave
Man misused
Forgetting his Neighbour
Dividing the White from the Black.

Alone of all living on Earth
Man can select
For his Progress
But Science is Neutral
Growing and waiting for Man's awakening.

Time is short
The atom splitting
Genes mutating
Is Life ending
On the Beach, where once it began?

What Hope
To find the Solution
To reconcile
Science and God
To direct Power toward Good.

Pure Science, searching for absolute Truth
Is Creation sublime
But non-directional
When applied
Who guides it to Man's better Future?

You, and I, and All around us
Our Vision is local
Our Spirit is here
Blind to a Planet delivered from Evil,
From Hunger, Poverty and Disease.

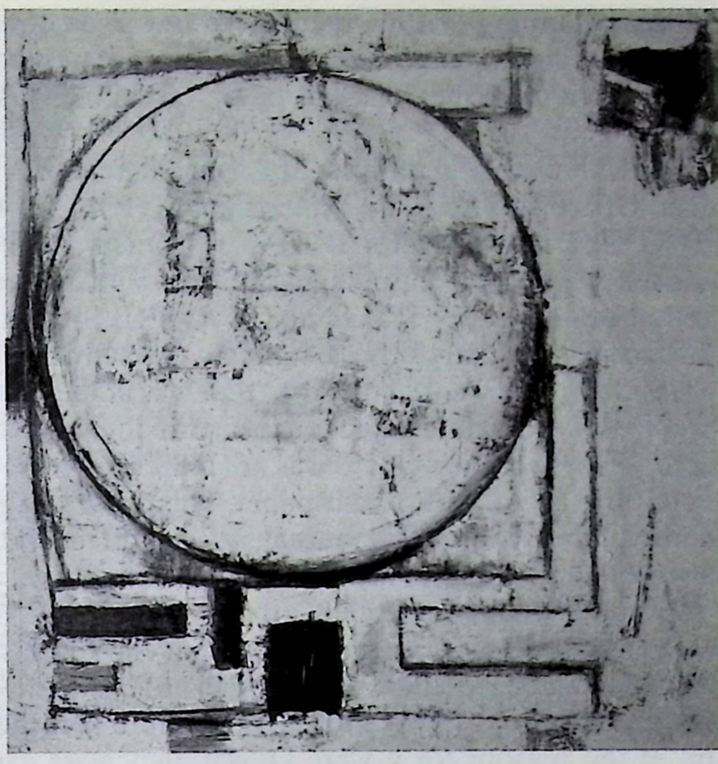
Never before was enough for all
Of Science and Knowledge and Power
To forge a new Faith
To use what we know
To construct our Utopian Future.

Roll out the Blueprints, the Seeds and the Bricks,
To plan, to plant and to build
Teach the Illiterates,
Ban the Diseases,
All can be done if we want it.

Millennia lie open before us
And we think of a year ahead,
Is this our Vision,
Man's ultimate Dream
Or the Birth of the World set free?

(Published in *Seminar*, New Delhi, October 1996)

Title 107



A small aluminium girder of most unusual shape, which I found surplus in the Vertical Assembly Building of the Apollo 11 Spacecraft at Cape Kennedy in 1968, is the catalyst of an exhibition of drawings and paintings by Paul Feiler. It now stands on my desk as a treasured souvenir of my many visits to the Apollo Launching site which I made as the Science Correspondent of the *Daily Telegraph*. When I showed it to Paul and asked him to paint a picture of the Moon for me, he incorporated its shape in the picture and painted a Moon above it. He told me many years later that this painting of the Moon inspired him to compose his two series of **Orbis** and **Lunatis**. © *Author's photograph*

By the beginning of 1965 there were few signs of an 'Utopian Future'— but the shape of things to come was visible in the race to reach the Moon. I could only fully report from the American side, but not from the Russian for which I had to rely on Agency reports.

The Chief of the American Space public relations was Julian Scheer, then at the Head Office of NASA, the American NATIONAL AIR AND SPACE ADMINISTRATION, in Washington DC. Apart from his large staff at the Washington Headquarters, he had organised at each of the launch sites, like Cape Canaveral, and at the Laboratories, like JPL, the JET PROPULSION LABORATORY, in Pasadena, California, subsidiary offices, staffed with many highly competent press officers.

Anything one wanted to know, that was in the open and not secret, like military satellites, was made available to all accredited press correspondents. I was one of them. To become accredited was not difficult, a form had to be completed and supported by the Editor of your paper. For any really great event, like Apollo 11 for example, there were 2000 journalists accredited, and special tribunes were erected to view the great event, in relative comfort and from as short a distance as was safe.

This open policy ensured that the world knew of American progress in the Moon race. The economic and political consequence of this attitude, so contrasting to the European and particularly the Russian policy, has never been fully analysed and appreciated. One was fully informed of future launches, told in detail of any delays and, if the reasons for it were known, they were explained. And this applied not only to the many successes which the American Space Programme could achieve, but also when disasters occurred, for example for Apollo 13. Julian Scheer deserves great credit for carrying out this far-sighted policy of NASA.

It had its political reason as well, as NASA and in consequence the many industrial suppliers of rockets, engines, electronic equipment and the thousands of essential components of satellites and spacecraft, all depended on the mighty flow of finance authorised and issued by the US Congress. This meant that Congress, Representatives and Senators, had to become aware of their local industrial contributions to the space programme and thus ensure their re-election. This American "pork barrel" policy needed the 'open policy of information' which was of such great benefit to us representatives of the press.

Occasionally it led to bitter competition and battles in Congress when for example Texas and Florida fought for the site of the Apollo Headquarter. Let me recall here that Jules Verne, in his book of 1865 about a flight to the Moon, had precisely foreseen this fight. Texas won then and also now. [See also page 176]

Early Bird—The first commercial synchronous Satellite   Title 108

By far the biggest and best example of the open information policy in relation to the American space effort, or as a cynic might put it 'the most expensive press trip ever', was laid on by the Hughes Aircraft Company of Los Angeles. On 8 March 1965, 38 science correspondents of the leading European newspapers met at London's Heathrow Airport and took flight TWA 703 to Los Angeles at the invitation of Hughes to be briefed about *Early Bird,* the first commercial synchronous communication satellite.

Previous satellites, like *Telstar* for example, had transmitted telephone and television signals across the Atlantic to great steerable parabolic antennae in England and France during the 20 minute period when the satellites in their low earth orbit of a few hundred kilometers, were visible to both the sending and the receiving ground stations. Hughes, however, made use of an idea proposed by the British science and science-fiction writer Arthur C. Clarke in an article published in 1945 in *Wireless World.* He wrote that if three satellites were placed in a geostationary orbit, 36000 km above the Equator of the Earth, they would be able to send and receive continuously from any point on Earth, as they would orbit at the same speed as the Earth below them. They would be stationary in space in relation to a point on the Equator on Earth and thus they were synchronous in relation to the rotation of the Earth.

Hughes had built two such satellites *Syncom II* and *Syncom III* for the US Army for their communications with Vietnam and were now ready with *Early Bird* for commercial communication traffic, offering 240 simultaneous and permanent telephone channels across the Atlantic. This was great news and Hughes were justified in spending $ 10000 for each of the European science correspondents, to fly them to Los Angeles and keep them in the Beverly Hilton Hotel for five days.

We were all most impressed by the excellent briefing we received from the top scientific and commercial management, from men like Dr Harold A. Rosen and Dr Fred Adler who had been responsible for the research and development of the satellite. Even more breath-taking were the huge test facilities especially built for the purpose, none of which existed for any commercial purpose in Europe. No less generous were the entertainment ideas of Hughes who had obtained 38 tickets at $ 100 each for the première of the film *Sound of Music.* (I regret that I could not stand the kitsch and left the show at the first interval.)

We wrote many stories for our newspapers, and when soon afterwards *Early Bird* took to its orbit and exceeded its makers' promise, Hughes had gained a lead in this new field and was to manufacture many more synchronous satellites in the following years for the USA and many other countries. Their press extravaganza had proved a good investment!

On 25 May 1961, President John F. Kennedy had given NASA the task to land a man on the Moon and return him safely before the end of the decade. That this was achieved by *Apollo 11*, with 6 months to spare, was the greatest technological achievement of the 20th Century. I was extremely fortunate to be able to follow the many intricate steps that had to be taken before man stepped on to the Moon's surface. As the Science Correspondent of the *Daily Telegraph*, my employer, expected me to give a full and clearly understandable account of these events, and if this meant commuting from London to Cape Kennedy and elsewhere in the United States, I only had to say so. My not inconsiderable expenses were never queried, always provided that I filed my reports quickly and substantially.

By March 1965 there was no longer a question "if" America would reach the Moon, but only "when". This I argued fully in a long feature article, published under the title "End of the Beginning in Space". One of the reasons why I was justified in writing this was the belated success of the *Ranger* programme. Started in August 1961, this unmanned spacecraft was designed for a hard landing on the Moon, sending back television pictures of the lunar surface during its last 28 minutes of flight before crashing. *Ranger 1, 2, 3, 4, 5 and 6* failed for a variety of reasons, and only *Ranger 7* on 28 July 1964 sent television pictures back to Earth. I was able to follow *Ranger 9* in detail on my visit to Cape Kennedy at the end of March 1965, after I reported on *Early Bird*.

Before any manned landing on the Moon could be attempted, a thorough knowledge of the Moon's surface had to be obtained, by the Russians as well as by the Americans. The Russians sent 24 unmanned *Luna* spacecraft to the Moon between 1959 and 1976, and achieved some remarkable successes. So for example, *Luna 17* soft landed on the Moon in November 1970 and launched a remote controlled vehicle *Lunokhod 1* which explored the chemical and physical properties of the surface for 10 months.

The Russian results were kept secret and I could do nothing about this, except nention the fact that 'a Russian vehicle had explored the Moon'. Had the Russians adopted the same 'open information policy' as the Americans, the *Daily Telegraph* would, no doubt, have sent me to the Baikonur Kosmodrome as readily as to Cape Kennedy.

So I was thrilled to watch on television at the Jet Propulsion Laboratory in Pasadena, California, during the morning of 24 March 1965, the live pictures of the Moon's surface which *Ranger 9* sent from the Crater Alphonsus, having witnessed its successful launch from Cape Kennedy three days earlier. Like everyone else, I was thrilled, the 'End of the Beginning' had been reached.

Reporting Space from Cape Kennedy — Title 110

Any launch from Cape Kennedy was always an exciting event. Life was easy on Merritt Island but not cheap, and it was pleasant to get there from London. A direct flight from London's Heathrow airport to Orlando in Florida was quite comfortable, even with my long legs in Tourist class, reading some space literature, present or future, thus passing the time agreeably. Often we flew on the most direct route over the icy wastes of Greenland, and one could imagine this to be some unexplored new planet.

From Orlando I drove in a hired Hertz car south to 'the Cape', where one of the many agreeable motels had a room booked for me. The car was an essential item, as the way to a press conference, or to the launch site, was always many kilometers away. Even the drive was exciting, through palm trees, semi-tropical bushes and trying to avoid small porcupines on the roads.

There was never enough time to read all the information provided by NASA, talk to all the American officials who could give additional facts, discuss with other learned colleagues additional details and the latest rumours. Next to write and telephone my reports to the New York office of the *Daily Telegraph* to a highly skilled clerk who typed my spoken words straight into a direct and private TELEX line to the London Office. There was never enough time to do it all.

The real difficulty was the time difference, 5 to 6 hours later in London, and therefore an early morning dispatch was essential from Florida. It was only much later, about 1970, that a primitive Fax gadget could be hooked on to my telephone in the motel and my written text arrived in New York instantly. It must have been one of the first FAX machines in use anywhere.

My first space reports from Florida always carried the date-line 'From our Science Correspondent at Cape Kennedy' until later, when the Apollo programme started. I still reported the launch from the Cape, but then it was a race to transfer to Houston, Texas, where the main Apollo Control Centre was located. It meant a hectic car drive to the nearest airport in Melbourne, Florida, from where special flights had been laid on for the many correspondents who had to get to Texas. For *Apollo 11* there were more than 1000 press men from all over the world, not counting the television crews and press photographers.

In Houston a small new town had grown up around the Johnson Space Flight Center which had by then expanded into a very large community of scientists, engineers and the inevitable NASA officials. It was often said that if the weight of their official paper documents did not equal that of the rocket, it could not be launched successfully!

Surveyor—Steps to the Moon Title 111

Ranger 7 was the first American spacecraft to show us in the Western World some of the details of the Moon's surface on 28 July 1964, and five days later, commenting on the significance of this feat, I had a full page in the *Daily Telegraph*, with large pictures, from this historic flight. It had the head-line "Man on the Moon in Six Years' Time". I was out by one year, man was on the Moon in five years! I detailed three steps to the Moon, *Surveyor, Gemini* and *Apollo,* all three being designed, constructed and tested at the same time.

I first saw the *Surveyor* unmanned spacecraft, conceived to soft-land on the Moon, at the end of March 1966, when I revisited the Hughes Aircraft Company in Los Angeles, the same company which had designed and built *Early Bird*, the first synchronous communication satellite. *Surveyor* was the logical successor to *Ranger*, designed to study further details of the Moon's surface. This was essential to refute once and for all the 'Dust Theory' proposed by Professor Tommy Gold of Cornell University, according to which several meters of fine dust covered the Moon. This would have made landing by man almost impossible.

Seven *Surveyor* spacecraft were launched between May 1966 and January 1968, two of which crashed and did not soft-land as they were designed to do. The five successes returned thousands of excellent photographs which allowed the choice of suitable landing sites for the later *Apollo* astronauts. The other success of *Surveyor* was the novel system of down-pointing radar combined with retro-rockets, which together allowed an automatic computer controlled soft-landing of both *Surveyor* and later *Apollo*. When I saw the first *Surveyor* in Los Angeles, I was again greatly impressed by the ingenuity of the design and the great testing facilities for it, imitating space by providing nearly complete vacuum and very low temperatures.

It was the size of these test chambers that was so grand, as the *Surveyor* in its folded position was 3 meters tall and the same in width. It was considered essential to test the whole spacecraft under the conditions of space, and not only each individual part separately. The correctness of this philosophy was attested by the success rate of five to two, which must be considered as good.

The other impressive reaction which *Surveyor* and *Gemini* conveyed to me was the slow, but unswerving path which turned the dream of manned flight to the Moon into the reality of technological progress. The long term planning was now seen to pay off, as part after part of the most daring expedition, ever undertaken by man, took its allotted place in this gigantic scientific enterprise. That there would be initial failures, and that these would continue into *Apollo*, was only to be expected, as any historian of technology will confirm.

Apollo will always remain for me the outstandig example of what scientific temper can achieve by foresight and planned execution of a large project.

Simultaneously with the exploration of the Moon's surface by unmanned spacecraft, manned orbital flights around our planet took place, both by the Russian Kosmonauts and the American Astronauts, as the spacemen were now officially called by their countrymen. The first to complete one orbit was Yuri Gagarin in his *Vostok* on 12 April 1961. Less than a month later, on 5 May, Alan Sheppard followed in his American *Freedom 7 Mercury,* but he did not reach orbit. Three months later, on 6 August, Guerman Titov in another *Vostok*, achieved 17 orbits in 24 hours.

It was not until 20 February the following year, in 1962, that an American astronaut, John H. Glenn, achieved true space flight, three orbits. At that time I was only a temporary science correspondent of the *Daily Telegraph,* but by forecasting the event, seven days in advance, I was able to give all relevant details on a full page. Its headline was "Tracking Stations for US Orbital Flight Span the World". I could show a World Map with the three orbits and the 14 tracking stations, a portrait of Glenn, a cutaway drawing of the *Friendship 7 Mercury* spacecraft, of the Hawaii station and of a flight doctor watching Glenn's medical profile while in orbit.

Glenn's great space flight gave the American people the long awaited assurance of success which up to then had gone to Russian kosmonauts. Glenn was a hero, not only to his countrymen, but also to all those in the West who supported man's exploration of space. I was one of these and have remained so ever since. Glenn later toured the world and gave a press conference at the American Embassy in London. On that occasion I asked him to define courage. He replied: "To know danger and to work through it". I should have written this up for my newspaper, but seem to have considered it not important enough to keep a copy, if indeed I ever reported it and if it was ever published.

Other *Mercury* flights followed, all in spacecraft named 'Seven'. There was Scott Carpenter in *Aurora 7*, Walter Schirra in *Sigma 7*, and Gordon Cooper in *Faith 7*. The enigmatic number 7 [see Title 310] was obviously a Good Luck symbol. All *Mercury* spacecraft achieved their tasks without any mishaps, and Gordon Cooper stayed in space for 34 hours during 22 orbits. But it was not only man's endurance in space that was shown to be possible without any ill effects, three different types of rocket launchers were tested, recovery from the Ocean proved possible and the Operation Center at Cape Kennedy was shown to be efficient.

Throughout all subsequent American space flights it was this center that was in overall command of all launch operations, and the astronaut was simply told what to do. I did not write any more about *Mercury* for the *Daily Telegraph*, as soon afterwards I left as a 'temporary', but only for a time, before returning for the full position as Science Correspondent in 1963.

I arrived again on 16 March 1965 at Cape Canaveral, the *Field of Reeds*, to witness and report two major American space flights, *Ranger 9* and *Gemini 3*.

Gemini 3 was the first American two-men spacecraft to test long duration in space for man and to prove the possibility of docking one spacecraft with another object, possibly a spacecraft, in orbit around Earth and later around the Moon. Both these tasks were essential for the subsequent *Apollo* program.

I left again on 28 March and during those exciting 12 days had 16 articles published in the *Daily Telegraph*, including a three-column feature article and a two-column front-page article. It had been hard, but most enjoyable work, involving taking minute-by-minute notes of the progress of *Gemini 3*. I considered myself not only lucky, but also honoured and privileged to take an active, a communicating, part in these impressive and thrilling events, all crowned by success.

From a technological and organisational point of view *Gemini* was a logical sequel to *Mercury*, as two astronauts were essential to carry out the multitude of tasks that were demanded from the crew. In their spacesuits, they sat side by side below their large hatches of entry and exit, and as an advance on *Mercury*, they had individual ejector seats, which fortunately however never had to be used.

Gemini was launched into orbit by a modified Air Force *Titan II* rocket, which was propelled by two self-igniting nitrogen liquids, hydrazine hydrate as fuel and nitrogen tetroxide as oxidiser. The great advantage of these propellants, compared to the combination of liquid hydrogen and liquid oxygen, lox, is the fact that the two nitrogen compounds are stable at ambient temperature, and in case of long delays at launch, they need not be constantly topped up, as cryogenic liquids require. For *Apollo*, however, lox and liquid hydrogen had to be used again. As chemistry is my academic discipline, the rocket propellants were of greatest interest to me, but too scientific to report about them in a daily newspaper.

Nine further *Gemini* spacecraft, 4-12, followed from June 1965 to November 1966 and were all highly successful. The first American space-walk, called in NASA-ese 'Extra Vehicular Activity', EVA, was done by White in *Gemini 4* and later by others as a standard operation. Long duration flights, 206 orbits in 330 hours, rendezvous and docking manoeuvres, followed after in short intervals and laid the solid foundation for the *Apollo* flights which followed in due course. I did not write about these *Gemini* flights from Cape Canaveral, they were already considered as a routine by the Foreign Editor of the *DailyTelegraph*.

For me a quite unexpected bonus was a visit to a Nuclear Submarine at Port Canaveral, only a few kilometers from the Space Centre, on my last day before leaving the Cape in Florida. During the inevitable delays of all space launches, I had driven around in my car and had discovered a nuclear submarine on a quay in the Port. But how to visit it? I simply walked down the gangway and asked the guard to fetch the officer of the watch to come and see me. Explaining my press status I asked for permission to come aboard, but he politely refused and told me this had to be cleared in Washington by the Navy Department and the British Embassy. "Please return in 24 hours" he said.

It was another example of the admirable 'Open Information Policy' (see Title 107) towards the press which ruled in America at the time. I doubt if a similar approach by an American representative of the press to a British or French nuclear submarine officer would have produced a similar answer. I returned next day and was invited to see America's fiftieth nuclear-powered submarine, the then recently commissioned *Nathaniel Green*, 7800 tons.

She was at Port Canaveral to fire, while submerged, two *Polaris* practice missiles from about 100 km out at sea, a standard procedure for all new submarines in order to calibrate their instruments with the aid of the many radar tracking stations available at the Cape. I was given a three-hour tour of her 'unclassified areas'. Walking through her three decks I was amazed by her spaciousness, so utterly different from all previous submarines I had seen in museums.

Wide gangways led to the officers' individual staterooms, from there to the men's quarters, on to the command post and on to the torpedo chambers. At the command stand curtains had been drawn over some instruments so that I could not see any calibrations or upper limits on several of the many instruments, although their functions were freely explained as depth gauge, underwater speedometer and so on. Forward of the command post, in the stem, I saw the chambers of 16 missiles, the large black cylinders housing at the time only practice missiles. I was told that the real *Polaris* missiles have a range of 4000 km and as no point on Earth is more than 2700 km from the sea, the submarine can keep any target on our planet covered.

The complexity of older submarines in Museums was nothing compared with that of a nuclear-powered one. I was not allowed to see the reactor engine room in the stern, but shown the oxygen producing water electrolysis installation and the waste disposal unit. Her Commander William Cossaboom told me "Once out on patrol, we are in constant receipt of message traffic, we get daily news broadcasts, and what the crew considered most important, familygrams from home." My report was published in full in the *Daily Telegraph*.

My second year as Science Correspondent of the *Daily Telegraph* was spent in more exciting overseas visits than my first, but still the majority of my working time in London was devoted to what I call 'Routine Science'. I give again [seeTitle 95] a selection of items written and mostly published the next morning in the newspaper.

JACQUES PICCARD'S SUBMARINE DRIFT IN GULF STREAM
UK III SATELLITE
SOVIET BATHYSCAPHE
PURE SCIENCE NOT TOPS SAYS MEDAWAR
VACCINE FOR GERMAN MEASLES

HEAVY WATER ESCAPE FROM PLUTO REACTOR AT HARWELL
BASIC ENGLISH SCIENCE LANGUAGE FOR SCIENTISTS
CALIBRATING EARLY BIRD COMMUNICATION SATELLITE
INDIAN FACTORIES SET PLUTONIUM EXAMPLE
RESEARCHERS CALL FOR MORE CATS AND DOGS

U.S. MARS PROBE SETS RECORD RADIO CONTACT
BRITISH WATER-COOLED UNDER-GARMENTS FOR ASTRONAUTS
WORLD'S LOWEST TEMPERATURE AT OXFORD
R O L F ROBOT IN BRITISH COAL MINE
AUSTRALIAN FLYING SAUCER CHECK

GOLD METAL PLATING ON NYLON DRESSES
1392 CATHEDRAL CLOCK WORKING AGAIN AT SCIENCE MUSEUM
U.S. SKYSCRAPER MODEL IN BRITISH WIND TUNNEL
EMIGRATE AND GROW
FRED HOYLE RETRACTS STEADY STATE THEORY (See Title 19)

VINLAND MAP OF 1440 PUBLISHED (Fake!)
COMET IKEYA-SEKI SEARCHED BUT ELUSIVE
FRANK DRAKE'S SPACE MESSAGE DECODED
SPACE AGE SCIENCE AT THE HOUSE OF LORDS
DIAL 44 FOR BRITAIN

MEN'S BREEDING STORM
E S T E C NOORDWIJK
E S R O II PROGRESS
BLUE STREAK LEAVES FOR WOOMERA
2001 – SPACE ODYSSEY FILM (BY ARTHUR C. CLARKE) REVIEW

Title 116

Two great Indians, Nehru and Homi Bhabha FRS (right) in friendly conversation on 2 June 1960. **Jawaharlal Nehhru** (1889–1964) became the first Prime Minister of independent India in 1947, a position he retained until his death; he had studied natural science at Cambridge and took a tripos degree. He first used the term *The Scientific Temper.* [See Title 341]
Homi Bhabha, FRS a Parsee by birth, sudied physics in Britain, specialised in nuclear physics, and at the young age of 41 was elected a Fellow of the Royal Society, London. After 1947 when India became Independent, he was appointed by Nehru to take charge of India's Atomic Science and Technology. He died tragically on 24 August 1966, when an Air India aircraft crashed on Mont Blanc in Switzerland. A non-denominational memorial service was held soon afterwards for him at the Royal Institution, London, a very unusual honour.
(Courtesy R. Kumar, Nehru Museum, New Delhi)

To India—The Kingdom of Homi Bhabha Title 116

On Friday 6 November 1964 I invited Mr E.C. Allerdice to lunch at my Club, the Savile. I had met him on one of my previous visits to New Delhi as he was the Chief Administrator of the Indian Atomic Energy Authority. He told me that India had for the last five years carried out atomic research, but had never issued any publicity about it. All this had been under the direction of Homi Bhabha FRS, India's foremost nuclear physicist. Mr Allerdice invited me to come to India and write about it, and I suggested a formal invitation from Homi Bhabha should be sent to my Editor, Mr Maurice Green. I cannot now recall if such a letter was ever sent.

On Wednesday 9 June 1965, a group of British science correspondents including Anthony Tucker from the *Guardian*, Ronnie Bedford from the *Sun*, Hugh McLeave from the *Daily Mail* and Victor McElhenny from *Science,* as well as myself, left London's Heathrow airport for Bombay by Air India, first-class. I had some difficulty to be there on time, as I was back from America only the previous night.

I had been to Cape Kennedy to cover the space flight of *Gemini 4* and wrote on 7 June about the successful recovery of the astronauts, McDivett and White, who had just performed the first American spacewalk. It was a front page report on 8 June in the *Daily Telegraph*. Having filed my story early in the morning from Cape Kennedy, I drove to Melbourne, Florida, and reached Newark in New York that evening. Next morning 8 June I left at 9.30 and arrived in London at 20.30. By taxi to my flat in Little Venice, where I found my faithful secretary awaiting me with the Air India ticket for Bombay via Moscow.

On all my previous visits to India I had flown via the Middle East, so Moscow was the first novelty on this trip. At Moscow airport I was very fortunate to find five gold medals of Soviet kosmonauts for my collection of scientific medals. The flight over the Himalaya mountains to Delhi was a spectacular sight. Flying over the Alps in the centre of Europe takes normally about 15 minutes and is marvellous, but to fly over the Himalaya Mountains took over one hour and has always remained in my memory. A repeat occurred on the return flight.

On arrival at Bombay we were greeted by Homi Bhabha, one of the most cultured scientists I have ever met. A Parsee by birth, he was not only scientifically most eminent, a Fellow of the Royal Society of London, but also highly gifted as a painter, as our group saw later when he kindly invited us to his home in Bombay. There, his excellent oil paintings were hanging on the walls. Later, I had the sad task to write his obituary when he was killed in an aircraft crash on the slopes of the Mont Blanc in 1966. His death was the saddest loss to India's science and to his many friends.

If one sails into Bombay Harbour from the Indian Ocean, one sees on the starboard side a white dome-shaped structure, a very tall chimney and other white buildings, all situated in a large garden with many tropical multi-coloured flowers. This would have been the sight to greet our group on the first morning in India, had we come by sea, but we arrived by car at Trombay, India's Atomic Energy Authority's Research Establishment. Not only its science and technology had been carefully planned by Homi Bhabha, the Director General of the Authority, but also its architectural and horticultural appeal. The most beautiful laboratory I have ever seen. After the death of Homi Bhabha, it was re-named after him, the Homi Bhabha Research Centre.

The most impressive sight inside was the plutonium production plant. Because of its high chemical and radiation risk, plutonium can only be extracted from spent atomic reactor fuel rods and must be handled by remote tele-control. Complicated chemical processes are needed for extraction and purification of plutonium, and all this must be done from a distance, a difficult and highly secret procedure which in the West and in America had never been shown to the press.

What I saw in Trombay was a large room full of pipes, valves, pumps, and containers in intricate complexity, yet forming a unified whole. Everything was made from stainless steel. No human being was visible through the glass windows, and yet inside these confusing pipes, chemical processes were going on, controlled by living beings far away. Had I been asked to imagine a plutonium production unit, I could not have sketched anything very different from what I then saw in front of me. But such was the impact that I could only marvel at the ingenuity of the Indian scientists and engineers who had designed and constructed this high-technology example of chemical engineering without—as I was told—any European or American engineering help.

I knew that some theoretical information about plutonium extraction existed in the literature, but to see it in three-dimensional reality was most impressive for me. As a chemist I had of course visited ordinary chemical laboratories and factories for many years, but this was an achievement that made me proud to be a chemist. I could not understand why similar visits had never been organised in Europe or America.

Secrecy is all very well—if it is necessary for industrial or for national security—for the design, drawings and working parameters of any chemical process, but a casual half-hour visit to Trombay's plutonium plant could not possibly have allowed any outsider, however omniscient in chemical technologies, to copy any vital data.

I wrote about it and had several articles published.

One might well ask, and we did ask, at Trombay, why produce Plutonium at all? It can be used in a future Breeder Reactor as fuel or alternatively it can be the explosive constituent of an atomic bomb. When highly purified as weapons-grade Plutonium, it has been stated that 500 grams is sufficient as a critical mass for a bomb, and we were told that Trombay had a capacity of producing it in kilogramme quantities, presumably per year. Dr Homi Bhabha assured us that India had no intention to produce any bombs, but if certain eventualities occurred, it would only take 18 months to do so.

In fact India did carry out a peaceful test explosion of an atomic nature on 18 May 1974, but apparently nothing further became known. By that time Dr Homi Bhabha had died and I had left the employment of the *Daily Telegraph*, so that I can only assume it was plutonium that was used as an explosive. No uranium enrichment plant was known to exist in India until our visit. Other tests were carried out years later, the last in 1998.

In the afternoon of our one-day visit to Trombay on 19 June 1965, we also saw the electronic laboratories. At the time of our visit, India was suffering from a severe shortage of foreign currencies and therefore pursued an intensive policy of self-sufficiency. The Electronic Laboratories were an excellent example. Started in 1952, four years before the plutonium production facilities became operational, Homi Bhabha had correctly foreseen that, without electronic equipment, neither atomic energy, nor rocket and space research, could be successfully carried out in India.

He therefore conceived the electronic laboratories as a joint establishment of school, university, industrial manufacture and government research centre. The first equipment made in 1952 were Geiger counters for atomic radiation measurement, followed by more general counting instruments. We saw a full scale production line, operated by women, of electronic research equipment destined for Indian universities, and I published a picture of it in the *Daily Telegraph*. Most welcome of all developments, Dr. Homi Bhabha told us, was the fact that some employees had reached the stage of leaving Trombay and setting up their own small electronic factories in the neighbourhood.

Two Chinese atomic bomb tests which had taken place shortly before our visit to Trombay had hardened Indian scientific opinion considerably, Dr Homi Bhabha said. Large quantities of plutonium would become available from two new atomic power stations to be built at Tarapur and in Rajasthan, expected to be operational in 1968. India would only join the Nuclear Non-Proliferation Pact, if all other countries, especially China, would also place their atomic power stations under international supervision.

Title 119

Daily Telegraph Editorial 22 June 1965

Note: SHASTRI LAL BAHADUR was India's Prime Minister from 1964 to 1966. He succeeded Jawaharlal Nehru on his death and when Shastri died in 1966 he was followed by Indira Gandhi. Shastri was a professional politician and held a number of ministerial appointments after 1961.

THE DAILY TELEGRAPH
AND
MORNING POST

DAILY TELEGRAPH - - - June 29, 1855
MORNING POST - - - November 2, 1772
[Amalgamated October 1, 1937]

TUESDAY, JUNE 22, 1965

INDIA'S ATOMIC DILEMMA

MR. SHASTRI'S refusal to embark on a nuclear weapons policy, despite increased internal pressure since the explosion of the second Chinese bomb, is always qualified. He is explicit that no bomb will be made "for the present," but will not commit himself about the future. Last week in London, while saying it was much better to work for the elimination of nuclear weapons rather than make them, he recognised that unspecified "eventualities" might arise which would leave India no choice. One wonders how long this morally admirable example of abstinence can be maintained.

In this situation there is a special relevance in the reports of our Science Correspondent on the present capacity and the potential of the Indian atomic energy establishments, which he has been visiting. It appears that, genuinely, no decision has been taken to "make the bomb," nor is there anything that could fairly be called a "crash programme." Nevertheless there is steady expansion under an ambitious long-term plan to produce atomic energy that, although intended to be peaceful, could have military applications. There is no doubt about the quality and zeal of the scientists. Highly significant is the emphasis on achieving complete independence in raw materials, know-how and equipment. Already a bomb could be produced in 18 months. Rocket manufacture is to begin in 12 months.

The arguments against an Indian bomb are strong. The waste of money would be as distressing as the bad example of proliferation. But the probability is that the Indian Government will be driven by the Chinese threat alone, quite apart from the possibility of proliferation elsewhere, to take the awful step before long. The only alternative would be a completely reliable guarantee by the major atomic Powers—and the acceptance of this in place of an independent deterrent would postulate a rare degree of moral courage by the Indian people. Hitherto Mr. SHASTRI has canvassed the utopian idea of a guarantee by all nuclear Powers to all non-nuclear Powers. Getting down to specifics, is it conceivable that Russia would join with America, Britain and France in a credible guarantee to India against China? Otherwise, would non-aligned India accept a Western guarantee, excluding Russia? This is the crux.

A few hours flight south of Bombay brought our group of five English science correspondents to Cochin on the south-west coast of India. It is a small town famous for its nearby deposits of black beach sands, rich in the chemical elements known as Rare Earths. These seventeen elements are found as oxides of metals of which cerium is the most common, used for lighter-flints. They occur in nature as complex mixtures, one of which is monazite, relatively abundant in the black sands about 160 km south of Cochin. Furthermore, monazite contains the radioactive element thorium, which may well play an important role in future atomic technology.

Apart from rare earths and thorium, monazite contains ilmenite as well, a mineral rich in titanium, so India is fortunate to have these important raw materials lying on its shores as black beach sands. Although only present in small quantities, at the time of our visit 3000 tons of monazite produced no more than about 1 ton of rare earths compounds and about 550 tons of thorium hydroxide each year. All rare earths compounds were exported to Europe and Japan, at the time earning 68 lakh (6 800000) rupees.

I found these statistics and the details of the chemical purification processes interesting but was quite certain that the Editor would not share my devotion to chemical facts. I refrained therefore from writing and telegraphing about them. Only in recent years have the rare earths found a new and important use as alloys in ceramic electricity conductors which, at very low temperatures, offer minimal resistance to the flow of the current.

What we saw and heard the next day, on 12 June 1965 when we reached Trivandrum, was more newsworthy. There India was building a space technology centre, only 80 km north of Cape Comorin, the southernmost tip of the Indian Continent and lying almost exactly on the magnetic equator. Homi Bhabha, who accompanied us on the whole of our journey throughout India, explained the significance of this fact for precise measurements of the Earth's magnetic field. At the magnetic equator the field's position is vertical and in the last two years, he said, 24 scientific rockets had been launched, a contribution by India to pure scientific research.

We were in the State of Kerala, distinguished by the highest rate of literacy in all India and by its great tropical beauty. We spent the night in an old rest house of the British Raj. Gracious, luxurious and through its architectural design cool and spacious, it could not have been more welcome in the tropics. It was surrounded by high palm trees, and so near to the Indian Ocean that the sound of the gently breaking waves lulled us to sleep. We all wished to spend a few days there to rest, all the more so, had we but known what was to come!

It would have been a pleasant break, but after a night's rest and a real English breakfast, another reminder of an Empire lost, we moved further south to the Thumba Equatorial Rocket Launching Station almost directly on the Magnetic Equator. The Geographical Equator is the ideal rocket launch site to leave the planet, as there the Earth's rotation gives the rocket the maximum additional velocity. In comparison, Thumba is about 900 km, Cape Kennedy about 3000 km and Kourou about 500 km north of the geographical equator.

Thumba's facilities, when we visited them, were being built up from the beginning through donations from, and by agreements with, France, the Soviet Union and the American Space Agency, NASA. The French Centaur Rocket was then assembled in Bombay. In its own way, Thumba was small enough to see it all in a one-day's visit, the store, the launch tower, the single rocket, the palm trees, the sandy beach and behind all, the Indian Ocean. An old deconsecrated church was used as an office. I said to Victor McElhenny, who knew Cape Kennedy as well as I did: "A bit small to reach the Moon"and he replied "It makes me feel sad, as I always do, when visiting poor relatives".

We saw a Centaur rocket being made ready for launching. It was programmed to fire up to a height of 100 km and there to discharge a cloud of sodium vapour so that scientists on the ground could study the velocity and direction of the wind. A nearby American Nike rocket was lying there, which was to repeat the same experiment at dusk, when the luminous sodium cloud would be particularly clear against the dark sky. For demonstration purposes a radar test rocket was fired for us and we could watch its accurate performance on radar screens inside a mobile American test vehicle.

The Soviet Union had supplied a very useful Minsk II computer, but Britain had contributed nothing, I was told. "We would greatly welcome collaboration with British scientists" Dr H.G.S. Murthi, the Test Director told me. The Thumba Station is an integral part of the Indian Atomic Energy Authority, relying on the scientific and engineering skills of Trombay. It was therefore not surprising that Homi Bhabha, the Director of the Atomic Energy Authority, should have included Thumba in our all-India tour.

About 10 years after our visit, the first satellite built by India was launched by Russia. It was named Aryabhata after an Indian astronomer of the 5th century. It was reproduced proudly on an Indian 2 rupee banknote, and has remained until the time of writing the only satellite ever to be pictured on any banknote.

It was of course the ambition of Homi Bhabha to show us all of his scientific kingdom. Such intentions are common when planning visits, and not only for foreign correspondents, and invariably carefully planned schedules are delayed. In fact I have often quoted my dictum: "Any press visit that is on time is a failure". Such was the case after we returned to Trivandrum to catch a plane to Madras and Calcutta. I cannot now remember what was the cause of the delay, but we spent the entire day, a Sunday, at the airport drinking countless Nimbu pani, the delicious drink of fresh lemon juice.

Finally in Calcutta, we went to the Saha Institute of Nuclear Physics, where Dr B.D. Nagchaudhuri, the Director, and his staff gave us a number of talks about the history (it was founded in 1951), the present and the future of the Institute. It was financed by the Indian Atomic Energy Department. As usual, plans for future large accelerators depended on finance, and it was claimed that the know-how of construction and all materials were available in India.

From Calcutta we flew to New Delhi, where we were taken to the National Physical Laboratory, called the N.P.L., as in England. Its function is also the same, the supervision of the National standards of weights and measures, and it was just another historical reminder of the Raj. The only noteworthy Indian aspects were an early change to the metric system, the development of small solar heaters for cooking, and experiments to produce artificial rain by the spreading of sodium chloride (salt) crystals from aircraft. [See also Title 129] I did not file any reports to London, neither about the Saha Institute nor about the N.P.L.

Onwards by night train to Chandigarh in the Punjab where we saw very briefly the beautifully modern, official buildings created by the famous French architect Le Corbusier. The day became hectic and incredibly hot as in our small Indian taxis we were driven north, about 100 km over dusty country roads, to the Bhakra Nangal Dam in the Himachal Pradesh area. The dam, claimed to be the largest of its kind in the world, produces water for irrigation and hydro-electricity for the production of heavy water.

Heavy water, deuterium oxide, (as ordinary water may be called hydrogen oxide) will be essential for India's future atomic reactors, Homi Bhabha explained. The amounts produced in 1965, when we were there, were already impressive, 14.1 tons per year. In comparison, 6 tons per year were made in Germany, 1.0 t in France and 3.8 t in the Soviet Union. At the time the surplus was large enough to send 13 tons of heavy water as a loan to Belgium. Two new reactors, then being built in India, were of the heavy water moderated natural uranium type, and they will require hundreds of tons of this.

In order to return to Delhi from the Bhakar Dam we went again by taxi, and this time the drive proved to be very exhausting. In my taxi were Ronnie Bedford and a 'minder', a senior official from the Atomic Energy Department from Bombay. At first the landscape was interesting, fields, irrigation canals dating back to the Raj, small villages, heavily overloaded and colourfully painted trucks, cows, and an occasional accident, mostly a truck on its side. But as the night came and the taxi-driver had difficulty finding his way on unknown roads, Ronnie and I became anxious to reach the Telegraph Office in Delhi to file our stories to London.

When we reached Delhi, the situation became impossible. Neither the driver nor the minder had the slightest idea of the geography of this large Capital city and we lost our way hopelessly. I then remembered the solution from one of John Steinbeck's novels *Travels with Charley.* Find a local taxi, tell him where to go and follow, naturally pay him for this service. But our minder protested, he had no expense allowance for such an unorthodox procedure. I lost my temper (A rare occasion!) and offered to pay the local taxi. Again this was not acceptable, as we were the official guests of the Department. Finally a taxi was found, the Central Telegraph Office was located and then to our hotel, the Ashoka. One or two stiff whiskeys restored good relations.

The next morning, 15 June, brought us to the last stage of the Indian Atomic Energy story—in fact it is at the first level of it—the mining of the uranium ore. This is being done at a place called Jaduguda—India's 'Uranium City', about 50 km from Jamshedpur. When we saw the uranium mine it was already producing 200 tons of ore per month which was transferred by train to Trombay for extraction and treatment. Although there is a uranium glut on the world-market, India cannot buy any because of foreign currency shortage and must therefore produce its own. When a new shaft is in operation, we were told that production would rise to 1000 tons per month.

Then, in 1965, a thousand houses had been built for the miners and their families in this desert-like area of India, where the temperature was 45 °C. The ore has a content of 0.07 percent of uranium. The new shaft will reach a depth of about 700 m and have a diameter of 5 m. Large drill bits made in England were at work sinking the shaft, when we saw this ambitious project.

It was all part of the atomic master plan, due to the genius of a physicist, Homi Bhabha, to produce electric power and a bomb, if the need arose. The plan was on a gigantic scale, and I published it in the *Daily Telegraph.*

Few people in India, and even fewer outside, realise today that Jawaharlal Nehru (1889-1964), the first Prime Minister of free India, had taken a Natural Science Tripos degree with chemistry, geology and botany as his subjects in Cambridge, England in 1909. Better known perhaps are the facts that he also studied law, worked as a lawyer and was frequently imprisoned by the British Authorities before Independence in 1947.

It was during these frequent periods in prison that his political and social ideas were formed and crystallised into a socialistic pattern of society in which science was to play a major role. He was stimulated by extensive reading of British philosophers and scientists, like Bertrand Russell, Joseph Needham, Julian Huxley, Waddington, Hogben and Haldane, scientists of the highest standing and most of them progressive thinkers of the left. Then after 1947, Nehru had the chance and the power to realise his ideas and to start a scientific revolution in his country, which was just beginning to become familiar with modern science. He was able to lay the foundations for a scientific and technological development which few other ex-colonial countries ever achieved in a single life time. This he called his 'Scientific Temper'.

During my extensive 'atomic' visit to India in 1965, I was totally unaware of Nehru's achievements and only learnt the full details 20 years later from the contribution by Professor S. Gopal to *Interdisciplinary Science Reviews* Volume 10 (2) on "Nehru and Science—Aspirations and Achievements" which I had invited as Editor of the Journal. [See Titles 341 + 342]

Nehru's first action in 1947 was to take charge of the Council of Scientific and Industrial Research, and he remained its President during his whole term as Prime Minister until his death 17 years later. He also appointed Homi Bhabha, to be responsible for the development of atomic energy in India, and when the first atomic reactor in India became critical at Trombay in January 1957, it was Nehru who inaugurated it. Another vital contribution was the establishment of National Laboratories in a wide variety of scientific and industrial subjects, which by the time of his death had reached over thirty.

A further unique contribution was Nehru's annual attendance and key-note addresses at the Meetings of the Indian Science Congresses. These meetings are equivalent to those of the British and of the American Associations for the Advancement of Science, where the audiences number in the thousands. It was for him always an occasion to hear the latest scientific news and to discuss them with India's leading scientists. His formal involvement with the Indian Science Congress dated back to the early 1940s when he was elected a Member of its Science and Social Relations Committee. He became the General President of the 1947 Science Congress at its New Delhi Meeting.

One example of Nehru's achievement was shown to us on our visit to India in 1965, one of the National Laboratories he founded. It was the Indian Institute of Technology in New Delhi, one of the five Institutes of Technology which were all generously supported by foreign countries. The one in Kharakpur enjoyed the support, financial and academic, of UNESCO; the one in Bombay by the USSR; the one in Madras had German help; Kanpur received assistance from the USA and the one in New Delhi had help from Great Britain.

Nehru had stated his views quite explicitly when he laid the foundation stone for the New Delhi Institute of Technology in 1959:

> "If modern life depends on science and technology, then we must seize hold of them, understand them, and apply them."

When in 1965 our group of British Science Correspondents visited the Institute, it was only half ready, yet such was the pressure and desperate need for technical education that the first students had arrived to take up their courses. The first degrees were awarded in 1966.

With my great interest in the history of science and technology, I was delighted that the New Institute had a geographical link with a theological University built in 1295 AD by Sultan Allauddin Khilji, near which it now stands. Nearby is the Qutb Minar with its famous wrought iron pillar, 7 m high, dating from about the 5th or 6th century AD. It has never rusted. This still awaits a final and definitive explanation why it has withstood the annual monsoon rains; it will remind the students of the Institute that Indian technology was once highly developed.

Land, buildings, services and salaries are paid by the Indian Government, while Britain funds research and teaching equipment not available in India and provided reciprocal visits of teachers and students. By the time of our visit, the British Government had donated more than half a million pounds sterling. Particularly appreciated were the close relations with Imperial College in South Kensington, London (my own college).

The inspection of the Institute of Technology was our last scientific event and we returned to Bombay. From there I sent the following telegram:

> EX BOMBAY 650619 PAWLEY SERVICE DT LONDON
> Owing aircraft breakdown and tour extension return delayed two days
> STOP Onstaying upfollowing possible exclusive angloindia technological
> university story STOP Greatly appreciate permission for three days
> local leave after utterly exhausting furnace temperature atomic tour
> uptaking personal invitation chief secretary kashmir MICHAELIS.

Mr Pawley, the Managing Editor, of the *Daily Telegraph* (DT above) granted my request by return telegram.

Two grave problems were facing the world in the mid-1960s: Atomic war and the population explosion. As I frequently pointed out in my Editorials in *Interdisciplinary Science Reviews* that if we did not find the solution to the dangers of an atomic war, it might well solve the population explosion. Therefore when the United Nations held a Conference on World Population, I asked to cover it for the *Daily Telegraph* and this was—by then as a matter of almost routine—approved.

Before the opening of the 12-day conference in Belgrade, a policy statement had been issued by the UN Headquarters in New York stating that "The United Nations will give in future more technical assistance to governments to implement population control methods." Brave words indeed, as it was also laid down in the articles of the conference that "there would be no direct proposals for action nor any specific recommendations."

The first U.N. Conference on World Population had been held in Rome in 1954, and the subject had since then become ever more urgent, so that for the second conference in Belgrade in August—September 1965, in excess of 1000 scientific and medical experts from 60 countries had assembled and presented more than 500 papers. As usual on such occasions, I could only report on one or two significant statements which were published in abstract.

Dr B.R. Sen, the distinguished Indian economist and later a Nobel Laureate, then the Director General of the United Nations Food and Agricultural Organisation, stated bluntly the only two alternatives: "Birth control or starvation". Of course, he also mentioned in his key-note address that vastly increased investments in agricultural productivity could offer a solution but "a sustained effort to expand production may be lost in a feeling of despair." He doubted that the financial resources required would be forthcoming.

An alternative to increased food production—better still as a concomitant to it—was birth control, family planning or population stabilisation as it was variously referred to at the conference. Oral contraceptives, one speaker reported, were then used by 3.5 million women in the U.S.A., but caused some concern among doctors. As an alternative, the Intra-Uterine Contraceptive Device, then relatively new, was recommended, as it was entirely independent of a person's psychology and social background. Population forecasts were most alarming and a doubling of the existing world population of 3500 million by the end of the century, then in the next 35 years, was predicted. It nearly came true. [See also Titles 388 and 390]

American and European Space—Noordwijk, ESA Title 127

In the second half of 1965, American space scientists achieved two great feats which I reported from London and which were prominently displayed on the front page of the *Daily Telegraph*. In the middle of July, Mariner IV sent back from Mars the first close-up photographs of its surface over a distance of 214 million kilometers. I wrote that this was a brilliant electronic achievement for American science, as such a mission had to be automatic, once the computers on Earth and in space, had been properly programmed.

This was of special interest, as the Russian Mars satellite Zond II, had failed, launched a few days after Mariner IV. When I discussed this later with D. Schneiderman, the Project Manager of Mariner IV at his Pasadena Control Center in California, he explained to me that Russian 'electronic policy' had been to switch the spacecraft's electronic systems constantly on and off, to preserve their batteries. The American policy had been to leave them in the switched-on position, starting from launch.

The second American space 'first' in 1965 was the successful rendezvous of two manned spacecraft, Gemini VI and Gemini VII, a feat never before attempted. Such space rendezvous is an essential part of the Apollo Moon Mission and for other space activities, like the building of a space station. It involves complicated orbital changes, calculated and commanded by computers, both on Earth and in space.

With these great preliminary steps towards Apollo in mind, I had of course watched developments near home with sadness. Great Britain's attitude to space had always been minimal, if it had existed at all, and the infamous exclamation of the Astronomer Royal Wolley "All space travel is bilge" was hardly encouraging as he represented the establishment view. However, other European nations had formed a European Space Agency, ESA, a European Launcher Development Organisation, ELDO, and a European Space Technology Center, ESTEC, in Noordwijk in the Netherlands.

What I saw in Holland was first-class science and engineering but on such a limited scale, when compared with America, that my sadness was fully justified. I reported of course fairly positively about the belated British effort in building the ESRO II satellite, after I had visited the Hawker Siddley Dynamics factory at Stevenage. ESTEC had constructed small but excellent vacuum and solar-heat imitation test chambers in Noordwijk and insisted during my visit that all their efforts were devoted to scientific satellites. One essential test for satellites is to be submitted to violent vibrations during rocket launch, and such a facility was also available. I was impressed with what had been achieved with so little money and such scanty political support.

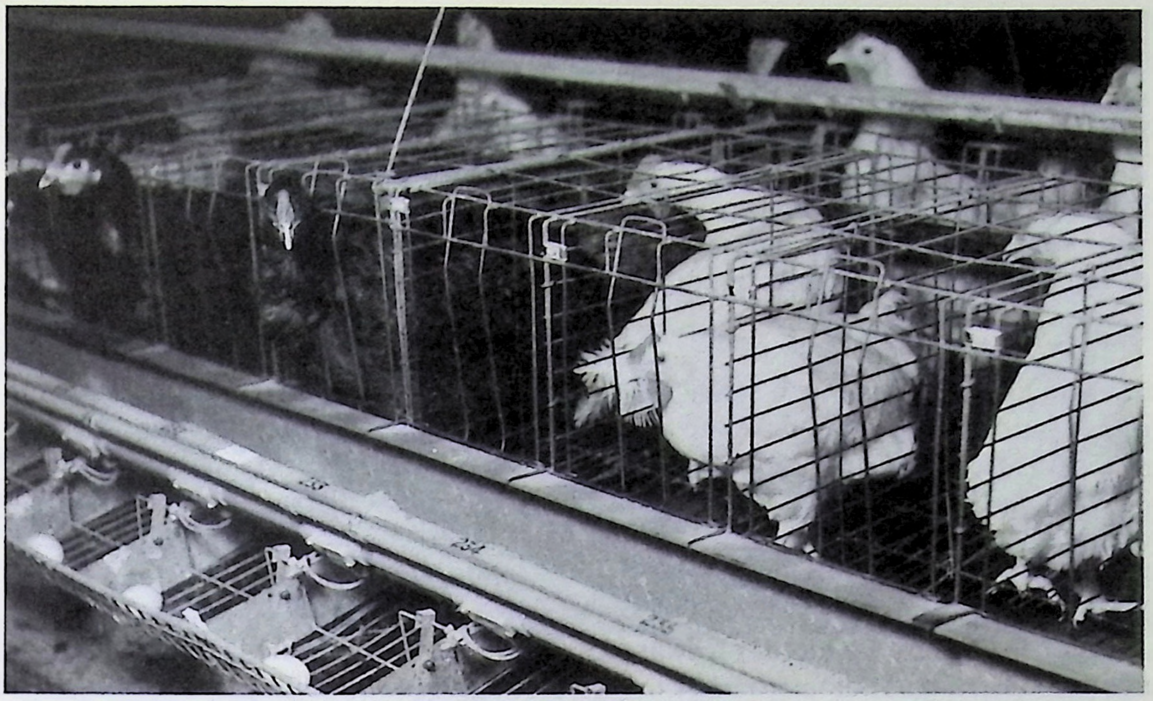
It was at the Atomic Conference in Geneva in 1964 that I met the Australian Lord Casey, the head of the team of Australian scientists at the Conference. He had a distinguished political career as Churchill's Minister representing him in Cairo during World War II, and later he became Governor General of Australia. I had no difficulty in talking to him, as I had lived in Australia for years and as he was interested in the communication of science. I told him that, in my opinion, Australia had many interesting scientific stories to tell the world, but that they had never been properly reported. "I shall see what I can do" he told me. I was very skeptical if he could, or would, do anything.

But I was wrong. It was on 1 March 1966 that a group of British science correspondents including Anthony Tucker of *The Guardian*, Nigel Calder of the *New Scientist*, Ronnie Bedford of the *Mirror*, C.L. Boltz of the BBC and myself set out (first class) on Qantas QF 752 for Sydney, stopping in Bangkok on the way. During our two-day stop in Thailand I was able to watch the national sport of Kite-Fighting, where the male and the female kites try to ensnare each other and endeavour to crash down together on either the male or female side of a rope in a large field. Heavy betting takes place. I wrote a brief story about this and it was published in the 'Mandrake' column of the *Sunday Telegraph*.

I also reported about Thai science based on a talk with Frank Nicholls, an old Australian friend, who was then the Special Governor of the Applied Scientific Research Corporation of Thailand. He was not very optimistic.

On arrival in Sydney we were taken to the Menzies Hotel in Carrington Street and given a small reception by representatives of Qantas. It was one of the Directors of the Australian National Airline who made the unforgettable welcoming speech to us: "I am sure that we can't offer you science mates the same exciting stories you are used to in Europe. There is only one field where Australia is leading and that is Radio Astrology." We were polite enough not to correct him, but some of us thought it a bad omen. Wrong again.

The next day, being a Sunday, I saw my ex-wife again after 12 years and we had a friendly, but rather formal reunion as our divorce had only become legally valid a few years before. In the evening Mervyn Scales, an old friend of mine from scientific film days [See Title 53] gave our group a party and we were joined by Dr Peter Pockley, the outstanding Australian science writer, then the Science Correspondent of the Australian Broadcasting Corporation. Both Mervyn and Peter quickly corrected our first impressions based on the Qantas speech and told us about some of the interesting Australian science that was awaiting us.



Title 129

The **Eggotron** is a device to record the effectiveness of selective breeding of hens by measuring the time-interval between eggs laid and also the time of day of laying. In the eggotron each egg laid is electronically registered, and the interval between eggs was reduced from 28 to 20 hours by various means. The Research was stopped 1995. *Courtesy CSIRO Livestock Industries, Australia.*

The first thing we learnt about Australian science on Monday morning, 7 March 1966, was the existence of CSIRO, the Commonwealth Scientific and Industrial Research Organisation. It is the federal government agency responsible for financing not only numerous great research institutes in Australia, ranging from radiophysics to animal genetics, some of which we were to visit, but also the expenses of our tour. The history of CSIRO and its precursors extends over many decades and its worldwide reputation is of the highest in the international scientific community, inspite of many attacks by Australian politicians, eager to claim preference for their own local interests.

The Commonwealth Fisheries and Oceanographic Laboratories in Cronulla, near Sydney, was the first CSIRO institute we saw. There we learnt of a novel theory to help rain prediction for the then drought-stricken New South Wales. It consisted in dropping hundreds of thermometers, the bathythermographs, into the ocean to a depth of about 300 m. It was hoped to measure rapid temperature increases of the ocean waters which in turn would predict increased rainfall. It was a long-term project over several years, and my story appeared a month later in the *Daily Telegraph*.

Later in the day we met Dr Edward G. (Taffy) Bowen of world fame, as he pioneered Australian radioastronomy many years ago. He was telling us at his CSIRO Cloud Physics Laboratory of a conventional aspect of rain-making, namely cloud-seeding, which had been investigated in Australia with many carefully controlled experiments since 1947. These confirmed similar work in America and Israel, and showed that success can be achieved in the first year, in Sydney an increase of 27 %, but that in subsequent years, due to a still unknown factor, the increase in rain is much less and during the fourth year it was only 3 %. The search for this factor was then his main work. [For attempts at rain making in India see Title 122.]

At the CSIRO Division of Animal Genetics, we had the pleasure of getting to know an English biologist, Dr Jim M. Rendel, a Fellow, and later Vice-President, of the Australian Academy of Science. His FAA is equivalent to the FRS of the Royal Society in London. When we met him at Epping, near Sydney, his main research work, based on a new genetic theory, was devoted to increasing the egg production of chickens in what he called an 'eggotron'.

By keeping his chickens in continuous daylight, he had bred a new strain of Leghorn which in the sixth generation had produced a significantly higher egg output. His eggotron was a fully automatic installation with continuous fluorescent light, with automatic feeding and water supply as well as soft jazz music playing non-stop. When an egg is laid and rolls down a gentle slope, it triggers a switch for recording this event for computer analysis.

Title 130

Standing in front of the great Radiotelescope in Parkes from left to right an unnamed Australian; Nigel Calder, Editor *New Scientist*; the Author; C.L. Boltz, BBC Science *Overseas Service*. Note in the background the first group of English visitors about to be invited to step on to the rim of the antenna-dish to be elevated 35 m into a horizontal position. *Courtesy CSIRO Radiophysics.*

Parkes, 300 km west of Sydney, is the centre of Australian radioastronomy with its large 69 meter diameter steerable parabolic antenna, to receive radio signals from deep space. Our group flew in a private aeroplane to the small agricultural town of Parkes which has its own airport, a common feature in the Australian outback. Before 1962, when the radio telescope started to operate there, the sparsely grass covered land was only used for sheep grazing, and when we went to see it, it was as dry as only an Australian drought can make it.

When standing below it, the telescope seemed huge, as the steerable antenna was itself mounted and centred on top of a high tower. At our arrival, the antenna was tilted so that its edge was touching the ground and we were invited to step on to it. Innocents that we were, we followed the invitation and immediately the immense dish started to resume its horizontal position and took us 35 meter up into the air.

We stood on a kind of strong chicken wire and our immediate reaction to this Australian 'welcome' was to retreat to the centre of the dish, where solid metal plates formed a firm surface. Standing on chicken wire 35 m up and seeing the ground between our feet was perhaps not the best introduction to a scientific marvel, but such was the Australian humour to greet a few 'poms'. (This is the Australian slang term for the English, supposed to come from the rosy red pomegranate cheeks of the first English settlers, as distinguished from the deep brown face colour of a true Australian.)

In the centre we found a trap door through which we entered the tower below, and we were shown round the impressive electronic offices which guided the antenna and received the signals from distant radio sources in space. The Parkes radio telescope was at the time the only one in the southern hemisphere and had in its three years of existence, achieved some remarkable results. So for example Dr J.G. Bolton told us, that they had measured the distance of the furthest object in the Universe visible from the south, a quasar 12000 million light years distant. Their pioneering Southern Hemisphere radio source survey is commemorated on the 50-dollar banknote of 1973. [Title 76]

We spent the night at the Coach House Motel and flew the next morning to Siding Springs, about another 300 km north, near Narrabri, still in New South Wales. Since our visit, Siding Springs has become as famous as Parkes in the world of astronomy, as it is now the site of the 150 inch Commonwealth Optical Telescope. The combination of an optical and a radio telescope in the same neighbourhood has proved a great success, and the results have further enhanced the reputation of Australian science. At the time we only saw the open ground and had to imagine the new giant instrument to come.

Title 131

One of the 96 antennae which compose the ring of the **Radioheliograph**, a small part of which can be seen towards the background. It was designed by Dr Paul Wild of CSIRO to give an on-line continuous record, once a second, of solar activity. *Courtesy Radiophysics, CSIRO.*

From Siding Springs onward, by private plane to Narrabri, about 350 km north, and then to Culgoora in the middle of the 'bush', where a brilliant new type of radio telescope was shown to us. Called a radioheliograph by its inventor, Dr Paul Wild FAA FRS, a former Royal Navy radar expert, it consists of a ring of 96 parabolic, or dish-type, spindly aerials, each of 17 m diameter. How different each looked from the massive structure of the Parkes giant! A few thin metal struts, covered with ordinary chicken wire, formed the 96 antennae, each mounted on a 8 m high light metal structure. Dr Wild's British sense of humour did not invite us to step on to one of his antennae to try their strength!

The mounting of the aerials is such that they can follow the Sun automatically during the four hours before and after noon, the best time for observation. In the drought-stricken landscape, this circle of the 96 dishes having a diameter of over 3.2 km, looks somewhat like a futuristic Stonehenge, destined for a religious ceremony by extra-terrestrial beings. The signals received from the Sun are fed into a computer and thus for the first time, changes in the Sun's corona and solar flares can be seen and continuously recorded on-line. One complete picture is received each second and Dr Wild proudly said: "It is thus the most complex radioastronomy equipment anywhere".

Each solar flare arises from a gigantic explosion on the Sun's surface and is equivalent to millions of man-made hydrogen bombs. The resulting shock waves reach our planet one and a half days after they have occurred and cause communication black-outs, magnetic storms and aurorae on Earth, as well as cosmic rays. Dr Wild explained that a forecast of these events will greatly help to safeguard astronauts and serve a useful practical purpose as well as increasing our theoretical knowledge of the Sun. The total cost of the radioheliograph was £ 200 000, the price of each antenna being £ 1000. A grant from the Ford Foundation had made this expenditure possible, as well as that for a novel optical telescope to complete the Culgoora Radiophysics Solar Observatory. It is an integral part of CSIRO's Division of Radiophysics.

Dr Paul Wild later joined the Editorial Board of *Interdisciplinary Science Reviews* and while I was Editor, I greatly valued his wide knowledge and experience. He became very interested in the campaign to build a high-speed rail link between Sydney, Canberra and Melbourne. He guided the difficult financial and technical negotiations for many years and always envisaged a high technology solution. Now that the German magnetic levitation system, Maglev, is not going ahead and not being built between Berlin and Hamburg, the chances for the Australian high speed link have for the moment greatly diminished. One day perhaps, this highly desirable high-speed rail-link may derive much benefit from Chinese or Japanese technical support.

I cannot say that our visit to the Woomera rocket range left happy memories. One reason was the constant anxiety about security by those who showed us round, the other was the despondent spirit pervading the whole range, which depressed all of us at the time. I wrote a long piece about Woomera, published under the title "Woomera's Empty Space". The title, not mine, was an excellent one and fully represented my feelings.

The range was conceived in 1946 as a joint British—Australian test ground for guided missiles, firing in a western direction over thousands of kilometers of desert. This direction does not benefit from the rotation of the Earth. Firing east, would directly point to Sydney, and no-one dared to suggest that. So, a few Blue Streak, Blue Steel, and Bloodhound rockets had been launched in the past, and by the time we came, an unmanned target craft, called 'Jindivik' soared across the cloudless skies. [See also Title 101]

I received the ultimate shock about Woomera's final humiliation 34 years later when a BBC news item on 28 August 2000 informed the world that tear gas [CS see Title 159] and water cannons had been used at Woomera to quell the riots which had broken out there. The angry inhabitants had attacked the guards and damaged the buildings, and stern counter-measures had to be employed to restore order. With strong security fences around the empty housing estates, when rocket activities had finally ceased and the engineers and their families had regained more equitable employment away from a desert—Woomera must have appealed to the Australian Authorities as the ideal site to house the ever—increasing number of illegal immigrants from Asia.

We were glad to return to more civilised places like Adelaide and Melbourne. In Melbourne we met Sir Gustav Nossal, FAA FRS, the distinguished director of the Walter and Eliza Hall Institute of Medical Research, well known for his advances in the field of immunology. I did not write about his work, which I considered already well known.

I was much more interested to get to know Dr Phil Law, the Australian Antarctic pioneer, whose books I had been reading for some time and who became a good personal friend during the following decades. A superb cook, his steaks are unforgettable. When I first met him on this visit, he was the Director of the Australian National Antarctic Research Expedition. [See also Title 51, Antarctic Catalyst]

He had just returned from the Antarctic, where on this latest expedition he had supervised the suitability tests developed by the Australian Army Psychological Unit for those working in the stressful conditions of the Antarctic. "Happy in the Antarctic" was the title given to my report by a subeditor.

After a splendid lunch given by the Directors of ICI in Melbourne, we flew to Canberra on Saturday 19 March 1966 and spent the rest of the weekend touring 800 kilometers of the famous Snowy Mountain Project. Started in 1949, it is one of the greatest Macro-engineering feats yet undertaken by man to reshape the planet for his benefit. It 'simply' meant turning west the easterly flow of two rivers to irrigate the dry areas of Australia's centre, instead of letting them run to waste into the Pacific Ocean.

By the time we saw the Project, 18 large dams had been constructed, 1600 kilometers of roads and mountain tracks had been laid down, 133 km of tunnels with an average diameter of over 6 meters had been drilled at speeds which set up world records, only to be broken again soon afterwards. On completion, we were told, its hydroelectric power would generate 4000 megawatt of electricity, four times the output of Britain's largest atomic power station.

We had all heard about 'The Snowy' but had not realised the magnitude of the project which greatly impressed me and my colleagues from London. Here was the use of science and technology for the unquestionable benefit of mankind, without damage to the environment. Most careful plans had been laid down and were being executed before our eyes, to safeguard or replant the trees, the shrubs and the grasslands covering an area of 182000 square kilometer. An excellent example of the Scientific Temper! Most remarkable of all the facts told us by Professor Tom Leech, the Director of Scientific Services of the Snowy Mountain Authority, was his statement that neither cost nor time would overrun the original estimates.

He explained the methods employed by the Authority to achieve this target. Quality control of all work by sub-contractors was uppermost, and for example the testing of kilometers of pipe lines was up to aircraft standard. Safety was next, and the accident rate was only one fifth of the Australian average, brought about by a safety lottery with A$ 100 prizes, provided a gang of workmen had been accident-free for three months. This lottery had also made it possible to stop insurance and thus saved A$ 300 000 in compensation each year. Any deviation from the original time schedule brought heavy penalties to the contractors.

With the Project almost completed, Professor Leech said: "We have made tremendous progress here in the use of geology for civil engineering and we are studying two further projects now: A giant underground water reservoir in Birdsville for dry Queensland, perhaps excavated by atomic bombs and a new harbour at Cape Preston". Nothing came of these feasibility studies and, regretted by all, the teams of successful engineers had to be dispersed.

Together with my colleagues, I spent three highly interesting days in Canberra. The climax was tea with the Governor General, Lord Casey, at Government House. We had a chance to thank him very sincerely for our magnificent tour of Australia which he had initiated after my request to him at the Geneva 'Atoms for Peace' Conference. He was most interested in our suggestions how to improve the scientific image of Australia throughout the world, and again he kept his word. For years I received a newsletter from Australia House in London, telling me about news items of Australian science.

The public carrier, Australian National Airlines, took us comfortably from Canberra to Perth in Western Australia, a distance of almost 5000 km, and then North by private Dakota, DC 3, to Mount Tom Price, another flight of over 1000 km. Only one colleague, Ronnie Bedford of the *Mirror*, accompanied me on this special visit to the biggest ever iron ore rush in Australia. When we got there we found a pleasant air-conditioned construction camp where the 630 men, Europeans and Australians, but no Aborigines, used bulldozers to slice down, layer by layer, a 1220 m high iron-ore mountain, crush the ore and load it into trains, taking the ore to a new harbour at King Bay, next to the existing one at the town of Dampier.

Ronnie and I were the first members of the British press ever to come and see this macro-engineering Project of Conzinc Rio Tinto of Australia, a Melbourne company in which London Rio Tinto had a 51 % controlling interest. Phil Urso, the American Construction Superintendent, welcomed us and said: "This is big by world standards." Estimated reserves were 17000 million tons of the richest iron ore known, 67 % haematite. Bert Brearley, the Camp 'Super', informed us that the camp was only 22° south of the equator, that the average shade temperature had been 36 °C during the last six months, and that the beer consumption at the camp during 30 days was three hundred 18-gallon barrels. As these were pasteurised for the tropics, the beer keeps in perfect condition, which we could confirm with great pleasure.

A railway line 290 km long was built to King Bay Harbour on which trains of 200 cars, each carrying 100 tons, bring the ore to enormous bunkers. From there, conveyor belts 3.2 km long load the ore at a rate of 6000 tons per hour into 100000 ton ships to be taken to the sole customer, Japan. This Big-by-world-standard project was possible as the Company had signed a 16 year contract with their customers, to provide 65 million tons of iron ore during that period. I wrote the story on my knees, flying back to Perth, sent it by telegram to London, from the G.P.O. in Perth, and it was published 14 days later in the *Daily Telegraph*.

As my return flight from Sydney to London was equidistant, whether I travelled west or east, I asked Qantas to give me a first class ticket via Hawaii and across the United States. It produced a number of good stories for the newspaper and was a perfect ending to my Grand Tour of Australia.

Having returned to Sydney from Perth on Passion Sunday 27 March 1966, I spent Monday morning, 28 March, seeing a number of friends and left by Qantas QF 550 at 19.10 hours to arrive at Los Angeles via Fiji and Honolulu at 17.30 on Monday 28 March Los Angeles. I had crossed the International Date Line at 180° west or east, and thus had the same day twice. This was the same phenomenon which Jules Verne described in *80 Days around the World* and which enabled his hero Phileas Fogg, so unexpectedly to win his bet of £ 20000.

I stayed two days in Los Angeles, the first with my friends of the Hughes Aircraft Company and learnt the latest details from Dr Robert Roderick, the Project Manager of Surveyor, the Moon landing spacecraft, and of the progress of its seven missions. From Richard Bentley I heard the future plans of Hughes to build bigger and better communication satellites, the successors to Early Bird. They were to be called Big Bird, and they proved a great commercial and technological success.

The second day I spent at the Jet Propulsion Laboratory, J P L, at Pasadena, a suburb of Los Angeles. It is a very large NASA research and satellite-production establishment, reaching back to the earliest days of rocket propulsion and space exploration, and it has the responsibility for the design, the choice of manufacturer, the launch and the results of all unmanned spacecraft. As I had been there several times before, I knew the scientists in charge, the 'project managers' as they are called, and learnt about the progress of Voyager, the mission to Jupiter and about Mariner, the mission to Mars.

Onward to New York and to the Grumman Aircraft Corporation at Bethpage, Long Island, about 60 km out of town. The headline of my story from there read: "Flat out over the Moon at 6 m.p.h." as I described how I had been given the chance to operate the training simulator for future drivers of the Moon Rover, being built by Grumman. It was an exciting experience, as the conditions of the simulator matched so perfectly the picture projected in front of me of the Moon surface. [About its use, see Title 218]

In Washington, my next stop, I saw Arnold Frutkin at NASA headquarters and my story was called "Queuing for the Capsule", the competition for a 'Brit' to take part in a USA manned spaceflight. However, this never happened. From Washington, still first class, I flew back to London.

Australia teaches Decimal Currency Title 136

When our Group of Science Correspondents was in Canberra in March 1966, it was just 3 months after Australia had converted its currency from Imperial £-s-d to the new decimal $-c system. It was known that Great Britain was to carry out a similar conversion 5 years later in 1971, and I therefore decided to visit the Commonwealth Mint in Canberra and the Secretary of the Decimal Currency Board in Sydney. The story I had written in Australia was published two months later in the *Daily Telegraph.*

Britain, New Zealand, Rhodesia, Fiji, Malawi and Bermuda were in 1966 the only countries 'unconverted' and obviously one could learn from Australia. It is seldom realised that the production of a new coinage requires a major industrial effort, and it meant replacing 3600 million old English coins by new ones. At that time the annual production of the Royal Mint was only 1000 million coins a year and it would obviously have taken 4 years to strike new ones. When Australia was faced with the same task in 1963, it went to the Royal Mint in England for help and when I saw Mr R.H. Osborne, the Superintendent of the Commonwealth Mint, he was looking forward to rendering a similar, very profitable, replacement service to the Royal Mint.

In both countries a new Mint had to be built, and in Canberra I saw the latest technology characterised by automation and far reaching mechanical handling by overhead cranes. The new Royal Mint was built in Wales. However the mechanical difficulties were small compared to the psychological ones to persuade a whole nation to change its habits. Australia took the 10 shilling base as its new Dollar value and thus many of the old coins could continue in usage, whereas Britain, for prestige reasons, retained the Pound Sterling base and was forced to strike a completely new coinage, except the florin, 2/- s, the 10 'new pence' coin.

I might mention here my own solution to Britain's conversion worries in 1971. Inspired by the circular paper slide-rules found in mediaeval astronomical books, the 'volvelles', I thought of patenting mine. But my great friend, Lord Hanworth, [See Title 36] persuaded me quite rightly to produce and sell the gadget, as getting a patent would be lengthy and costly.

I therefore took my model to the General Manager of the Daily Telegraph, Mr H.H. Stephen, and he was delighted to produce and market it as a *Daily Telegraph* product. The 'New Currency Converter' is a circular cardboard disk of 11 cm diameter, with the two subdivisions of the pound sterling printed on it. [See Title 217] These two concentric circles, the new decimal on the outside, the £-s-d on the inside, are linked by a small transparent cursor which allows instant comparison of the new currency with the old one. It was sold by the ten thousands and I got a welcome royalty from my only invention. [See Title 78]

In spite of the very generous travel allowance which I received from the *Daily Telegraph* during the 10 years I was a member of its staff, I would never have been able to visit and report from all the major Commonwealth countries, Australia, Canada, India, New Zealand and South Africa, had I not benefited from many generous invitations, including travel expenses and air fares. My great tour to Antarctica and the South Pole was a present from the USA, but my frequent visits to the USA to report space science were to a large extent paid for by the *Daily Telegraph.*

Invitations often came by chance, as either an industrial concern, like Hughes Aircraft of Los Angeles, or a country like South Africa for example, decided that their scientific image in England needed to be improved for a variety of reasons, of which of course I was never informed. All Commonwealth countries had diplomatic representation in London, the High Commissions, and these included Scientific Attachés whom I knew well.

They had formed a Luncheon Club, and I was once invited to address them. My subject was "The Comparable Task of Science Attachés and of Science Correspondents". Both had to watch for new scientific developments, report them in a language understandable to non-scientists and to transmit these news as speedily as possible. The reports of the Attachés were often pigeonholed and forgotten, I was told, and I could vouch for the fact that the stories of the Science Correspondents suffered a similar fate. I think I proved my case of great similarity between these two professions.

It was therefore not difficult to suggest to the Attachés that a visit to their country would be welcomed by my Editor, which was perfectly true. The prestige of my Newspaper was second only to that of *The Times,* and frequently its Science Correspondent, Pearce Wright and I worked closely together to obtain invitations. Then, when abroad, for example at the French rocket launching station at Kourou in French Guiana, where we shared accommodation, we quite naturally compared our reports before filing. Both newspapers benefited, and we never scooped each other.

For me, a special relationship developed with the Science Attachés of the then West German Federal Republic: Hans Mohrhauer, Carsten Salander and Ulrich Däunert. As long as funds were available, we planned together the annual visits to Germany and jointly chose the participants. This arrangement was welcomed by all, the newly founded West German Republic, whose scientists were anxious to re-establish relations with their British colleagues, who in turn, would read about German research from our reports in British Newspapers. [See Title 168]

An invitation by the BBC to visit their installations on Ascension Island was a typical example of something quite unexpected. Discovered on Ascension Day 1501 by the Portuguese Navigator João de Nova Castella, who gave the island its prophetic name, the Island had remained uninhabited until 1815, when British marines were stationed there to discourage Napoleon's escape from St Helena, 1100 km away. It has remained British ever since, and in modern times had become, because of its unique location on 0° and 0°, the Equator and the Greenwich Meridian, a vital centre for earth and space communications from the middle of the Atlantic Ocean.

Cable and Wireless, the commercial British telecommunication Company, were the first to utilise the Island's singular location and their underwater telegraph cable from England divided there in 1899, one branch going to South America, the other to South Africa. Later the BBC erected broadcasting towers on the Island, also beaming its short-wave broadcasts to the same two southern Continents. During World War II American Army engineers built Wideawake Airfield on the Island for the US and the Royal Air Forces, so that by the time NASA planned the Apollo Moon Project, it could easily place a ground station on Ascension to receive communications from space. Rumour had it that the British and American intelligence services had listening posts on the Island, but of course I was not shown these during my visit.

What I saw, when I landed after a rather spartan flight in a BBC-hired plane, was amazing enough, and I would not have had much difficulty in imagining myself on the Moon. An extinct crater had formed a 860 m high mountain in the centre, and around it was a small green fringe. Below it, a desert of grey dusty lava, no green blade or tree in sight. Everywhere radio towers with small huts at their base were the only evidence of man's existence to exploit the Island's position for communication.

Cable and Wireless had kept company housing on the Island for over a century for their 300 men, women and children which created great envy from the American engineers and soldiers—they had to fly to the nearby South American brothels to satisfy their sexual needs, as they were not allowed to bring their wives to the Island.

My news story, published 27 April 1966, four days after my visit, was called "British Equipment Link in Manned Moon Shot" and just mentioned that the BBC was about to increase its broadcasting facilities there. I stayed only a few hours on Ascension, but the most extraordinary sight was the green fringe of the mountain, called appropriately 'Green Mountain'. It was high enough to catch the moisture of the trade winds, and thus allowed fruit and vegetables to grow there in sufficient quantity for the permanent British inhabitants

My third year, 1966, as Science Correspondent of the *Daily Telegraph*, was one of some success, and at the end of the year I compiled some statistics. I estimated, as accurately as possible, the distances I had travelled, 101 920 km of which the *Daily Telegraph* had paid 7.4 percent. I had written a total of 302 stories, 44 of which were illustrated, and deducting 52 Sundays, almost exactly one story each during 300 working days. Of this a total of 281 were published, a percentage of 93 percent. I thought I could consider myself a satisfactory Science Correspondent, and I was made to feel that this was also the opinion of the Editor and the Owner, Lord Hartwell.

I give again, as on Titles 95 and 115, a selected list of titles:

TRINITY HOUSE'S LIGHTHOUSES AND SCIENCE
MOON INTERNATIONAL TREATY
RADAR ICE THICKNESS MEASURED
VINLAND MAP RENEWED CRITICISM
LINEAR MOTOR POWER

EUROPEAN SPACE SYMPOSIUM, BRIGHTON
H-BOMB RAISED AFTER 82 DAYS IN SEA
PROTOTYPE FAST REACTOR FOR DOUNREAY
GENERATOR BREAKDOWN AT CERN GENEVA
DEATH OF LAKE ERIE, AUSTRALIA

ANTIQUE SCIENTIFIC INSTRUMENTS AND BOOKS
PICCARD GETS MONEY FOR KON-TIKI SUBMARINE DRIFT
PROTEINS FROM LEAVES
ISRAEL'S SOLAR TURBINE
SCIENCE FOR NEW COUNTRIES DISCUSSED AT HOUSE OF LORDS

HOLLAND'S DELTA PLAN AS SAFEGUARD FROM FLOODS
BRAIN DRAIN DEBATE AT HOUSE OF LORDS
BRITAIN INVITED TO SOLVE U F O MYSTERY
ASTROLABE SOCIETY VISITS OXFORD MUSEUM
ROYAL SOCIETY MEDAL FOR ISSIGONIS, MINI-CAR DESIGNER

CIRCADIAN RHYTHMS
SEABORG SUGGESTS ATOMIC POWER FOR HEART
SPACE CABIN TRAINING UNDER WATER
WATER–COOLED SPACE SUIT
U F O UNIDENTIFIED BUT UNDENIABLE

In 1966 I was 50 years old. If I have written little about my private activities so far, it is simply because they meant less to me than my work. After the break-up of my marriage with Ann and my return from Australia to London in 1954, my first priorities had to be to find a job, to earn some money and of course a flat to live in. To meet a woman to charm my leisure, a rare luxury, did not rank very high in my endeavours.

My greatest joy on my return to London was that all my old friends, whom I left behind when I went to Australia in 1950, were delighted to see me again in 1954, as if I had been away only a few weeks or months. Among them were Standish and Dodi Masterman, living at 7 Hanover Terrace in Regents Park, London. He was a chemist by academic discipline like myself and was then working at a Government Department concerned with rocket fuels.

Towards the end of World War II, Standish had been sent on a secret mission to Poland where the first of the German V 2 rockets had been captured by the Russians. In order to get to Poland he had to travel through the Middle East, Iran and then North to avoid German Armies. He was to investigate the chemical nature of the fuel and the quantity carried by each rocket, as well as weight of explosive, in order to estimate the range of the V 2 and thus the danger to Britain. Standish had inherited a small fortune, but had remained a member of the Communist Party, and when later the Government excluded him from the secret work on rocket fuels, on which he had become a great expert, he was transferred to another Department concerned with the conversion of low grade fuels to high energy fuels. His political views meant nothing to me and he was always a close friend.

His wife Dodi was an accomplished artist and had achieved a high reputation as a book illustrator. She drew a charming little picture for my book *From Semaphore to Satellite*, [see Title 69] showing a youngster reclining on a sofa, intensely involved in a telephone conversation. Theirs was a perfect marriage between the arts and the sciences, and I was delighted when Standish offered me his basement flat as my new home in London for a very reasonable rent. To live in one of the most desirable parts of London could not have been better, as simply by crossing a road, one was inside Regents Park, one of London's most beautiful parks. It had a small lake, full of water birds and swans, many trees and carefully tended flower beds. At the back of the house was a mews in which I could garage my car, and in the next door mews flat lived Tony Osman, a science correspondent colleague.

Lord and Lady Sainsbury lived at 3 Hanover Terrace. I had shared a pram with Babette 50 years ago in Berlin, in the days of World War I. We had remained good friends ever since, and this continued after she married Alan.

Having found such a delightful home and also soon such a challenging and highly interesting job, editing *Discovery* [See Titles 62 and 63] I started to relax and enjoy life, to which Cecily de Monchaux then contributed so much. She was a psychologist at the University of Sydney and a friend of Ann's through whom I met her. She had come to London to continue her research and also found a charming flat in York Terrace, another of the Nash Terraces in Regents Park, only a short walk from Hanover Terrace. Her flat was an attic converted into a small pent-house, while mine was the kitchen quarters converted into an ordinary three-room apartment.

Cecily's French grandparents had emigrated to Australia and she was of course a perfect Australian lady, but her French ancestry was clear in her love of culture, of literature, of music and in her exquisite gastronomy. She represented all a man could wish for in a woman, as she was equally perfect in love-making. I was deeply in love with her and I knew that my affection was reciprocated. Had not her cancer developed very rapidly and led to a quick death, I am sure a very happy marriage would have ensued.

Of all the many other friends I would like to write about are Colin and Ann Ronan who became very close friends. I mentioned Colin before [see Title 39] as one of the early members of the Scientific Film Association, and as a gifted astronomer and musicologist. Ann had trained as an opera singer but did not continue in her career when she married Colin. After their marriage, they purchased a lovely old house near Cambridge, but later moved back to London to a much smaller house in Jeffreys Street, NW 1, where I often visited them, particularly as Ann was an excellent cook.

When their marriage broke up because Colin, stupidly as all his friends said, fell in love with the wife of a clergyman, he moved back to Cambridge and died in 1994. Ann remained in London, started a scientific picture library, which she ran highly successfully from London and later from Bishops Hull, near Taunton in the West Country. She helped me frequently with historical pictures and also in the preparation of the annual Index for *Interdisciplinary Science Reviews*. But this was in the 1970s and 1980s and I must return to the 1950s and 1960s.

I cannot now remember when I bought my first Landrover, but it was the ideal car for London, as it even frightened the taxis into giving way. It was also very suitable for my holidays in Cornwall, where I explored the old tin mines of the 19th century. The ruins of their steam power houses and mine shafts were often on exposed cliffs, and a Landrover was essential to get near and to draw them. I watercoloured them afterwards at home.

My 50th Birthday—22 August 1966 Title 142

I kept a careful record of this day, living at 7 Hanover Terrace, Regents Park.

6.15	Woke up
6.20	Bath
6.30	BBC News: Murderer of three policemen hunted, junior doctors strike
6.40	Got laundry box ready for collection
7.00	Switched to BBC Music, started these notes
7.05	Made breakfast, café au lait, two slices of cervelat sausage on toast
7.25	Started work on correspondence
7.55	Joan telephoned and wished Happy Birthday
8.05	Collected *Times*: 'Union in Pay Revolt' and *Daily Telegraph*: My story: 'Earthquake Advice to Holiday Makers'
8.40	Shaved, made bed, more correspondence
9.40	To bookbinders Ex Libris, ordered 9 small volumes of Galileo in vellum
10.40	Left for D.T. office by car having bought 75 cigarettes on way
11.10	Arrived at office
12.15	Left for my Club, the Savile
12.40	Lunch with David Martin who told me about his President Hinshelwood
15.05	Back at D.T. office
15.20	Left office and returned home
15.45	Back home, started abstracting B A. Presidential Address on 'World Population and Land' for 1 September publication
18.00	To Joan's flat in Chiltern Street, a few kisses but no present
18.30	Left with her for Albert Hall, Promenade Concert
19.30	Met Colin and Ann Ronan there, Bruckner's Seventh Symphony, which I found Teutonic and Wagnerian
22.00	To dinner at Gore's Hotel, Queens Gate, very pleasant with good food and drinks for all four of us
23.30	Sat with Joan in car and talked about our future relationship. Necked a bit. She demanded "All or nothing", marriage before sleeping with me. Decided this was not for me.

23 August

1.30	Took Joan back to her flat
1.45	Went to sleep alone at home.

I have described on Title 4 my Lutheran faith in outline, how its simplicity and its direct link with God have attracted me and how I have remained faithful to it. From this has grown a much more complex, a scientific, philosophy as I grew older and devoted my life to science in its many different facets. Now, over 80, I have called this attitude 'Scientific Temper'.

Quite recently, in 1997, I found that Article 1 of the Constitution of UNESCO, the United Nations Educational, Scientific and Cultural Organisation, provides a clear summary of a philosophy like mine. I quote:

> "To contribute to peace and security by promoting collaboration among the nations through education, science and culture in order to further universal respect for justice, for the rule of law and for human rights and fundamental freedom which are affirmed for the peoples of the world, without distinction of race, sex, language or religion, by the Charter of the United Nations "

However much, or little, UNESCO has during its more than 50 years of existence, been able to translate its credo into practice, its successes have not been inconsiderable. I consider these aims also applicable, as far as possible, to individual human beings and I am glad to accept this credo. In its original and widest sense, philosophy is considered as the love, study and pursuit of wisdom, and during my life I have found no better way to define my philosophy.

During my 20 years as Editor of *Interdisciplinary Science Reviews*, it was my duty to write an editorial for the 80 issues I edited, and on many occasions I pleaded for Interdisciplinary Wisdom. [See Appendix II for a List] I had come to the simple conclusion that the great problems facing mankind now and in the future, like atomic warfare and proliferation, population explosion, the need for increased world food production, the preservation of the planet's limited resources, the provision of efficient international disaster relief, improved health for the underprivileged, the popularisation of science for the general public, the need for global engineering to anticipate global warming, the conquest of the drugs menace—religion's chemical surrogates—or the invention of a non-lethal peacegas to combat terrorism, and many others—these problems can only be solved by Interdisciplinary Wisdom. Neither Cabinet Ministers nor Nobel Laureates alone, however wise, will master these problems, and my simple philosophy was to urge interdisciplinary collaboration. Perhaps only the example of Pugwash stands out, where politicians and atomic scientists met regularly for many years and had the success of reducing the threat of atomic war. It was a first attempt, and I hope it will lead to further joint efforts. To introduce Science into Culture was basic in my belief, the Scientific Temper.

Looking at the list of the Ten Commandments I could find only two which I have been tempted to break. I have never killed anyone, nor have I borne false witness and I have remembered the sabbath day, except when urgent work demanded otherwise, which I admit occurred frequently while working for the *Daily Telegraph*. For the Monday morning newspaper, all journalists have to work on a Sunday, although then Saturday is a free day instead.

When however I was also required to file for the *Sunday Telegraph* during an Apollo Moon flight, I had a seven-day working week, as I have again now, writing this book.

The two commandments I have been tempted to break were 'You shall not commit adultery' and 'You shall not steal'. There may have been a few occasions when I was sorely tempted to sleep with a married woman, but I have never done so. I had suffered too much by my wife's desertion for another man. So I decided never to inflict the same unhappiness on anyone else. Nor have I ever had an affair with another woman while my own marriage lasted.

Every collector must have been tempted to steal a desirable item, if he could not afford to pay for it. I have been tempted, but have never stolen anything. I have often coveted an antique scientific instrument, a book, a scientific medal or a scientific banknote, but never acquired any item illegally without paying.

The conflict of my principles arose at quite a different level. I knew when I joined the staff of the *Daily Telegraph,* well-known for its strong conservative political attitude, that it might lead to differences of opinion as I am of a liberal and progressive persuasion. This never arose, at least not openly. My articles were factual and never had a direct political content.

I can only recollect one instance when I challenged the Editor about one of my contributions which had not been printed. During a visit to the French rocket launch station in Kourou, I had the chance of seeing the nearby French penal colony on Devil's Island. I made a rather grim pen-and-ink drawing of the punishment cells to accompany a brief article, which I thought might be interesting during the time when the French novel *Papillon* was much in vogue. When I asked the Editor why it was not published he replied: "Do you think that the readers of the *Daily Telegraph* would like to be shocked at their breakfast table?" I was rather proud of my sketch! [On Title 228 I have here, at last, published my contentious article and sketch].

The conflict that did arise and led to my leaving the newspaper was about the desire of the then News Editor, a certain Mr Eastwood, for me to write only about 'bad science' and 'anti-science' events. This I was not prepared to do.

My Politics Title 145

I could never understand how a scientist could be a Conservative. His vocation to discover new knowledge must lead to progress, if applied for the benefit of mankind, the Scientific Temper. Of course, if he is engaged on war research, and to do so is his own free choice, then voting conservative will only lead to a continuation of war preparations, and that may well be his decision. Fortunately I was never placed in this situation of ethical conflict. I have always believed that science must be used for the good of all mankind. [See Title 105 where I have tried to explain my Belief]

I have once been a member of a political party, the British Labour Party, for about one year, in 1945, after the end of World War II. This was then the general feeling in England, at the time when Winston Churchill was defeated in the General Election of 1945. I was then proposed as a member of the executive committee, and later as the treasurer, of the Association of Scientific Workers. However, when I found out that the Committee was of strong communist persuasion, I promptly resigned as a committee member and also from the Labour Party. These were my only active participations in Politics.

While living in England for 63 years of my life, from 1933 when I was 17, until 1996 when I was 80, I never found a political party which I could wholeheartedly support. None advocated science sufficiently strongly as a means of solving the many problems of the country. Following the example of my father, who voted in the 1920s for the Central Party in Germany, although Roman Catholic dominated, and following the image of Mr Oldershaw, my tutor in Maidenhead, who had tried to be elected as a Liberal Member of Parliament but had failed, I was so impressed by these two outstanding men, that I wanted to conform to their example in my own life. I became, and am still today, a progressive liberal and whenever there is a chance to vote, I give my support to that party.

I have seen very few instances when science entered the field of politics at all. This occurred on very rare occasions in the House of Lords. [See Title 369] Apart from the Hereditary Peers, a not insignificant number of eminent scientists and engineers were awarded Life Peerages and occasionally debated science in its various aspects. I knew a few of them, Lord Todd [a Member of the ISR Editorial Board], the Earl of Bessborough, Viscount Hanworth, [a close personal friend, see Titles 36 and 37], Lord Shackleton, Lord Ezra, Lord Ashby [ISR Board Member] and Lord Porter [ISR Board Member]. Lord Ritchie-Calder has so far been the only science writer to be awarded a Life Peerage and I wrote about his Maiden Speech in the House of Lords, which was published in the *Daily Telegraph* on 27 October 1966.

As this dictum is partly philosophical, partly political and also has a biological connotation, I should like to elaborate it here. It was H.G. Wells (1866-1946) who in his book *The Fate of Homo sapiens* wrote in 1939:

> "Adapt or perish, that is, and always has been,
> The implacable law of life for all its children"

At one stage of my book collecting I owned a complete set of First Editions of H.G. Wells and I had read many, though not all of them. When I had to sell them, a friend of mine, David Fishlock, bought them and presented them to the Athenaeum Club in London. A worthy place for the books, as H.G. had been a member for a short time when he was asked to resign from the Savile Club. [See Title 338]

I was reminded of the Implacable Law 'Adapt or perish' when I was invited by a good friend, Bartholomew Nagy, a palaeo-chemist at the University of Arizona, Tucson and an editor of *Precambrian Research*, to write an editorial for one of its future issues, on a subject of my choice. It was certainly a challenge, and what I wrote was published by Elsevier Amsterdam, in his Journal Vol. 13, pp. 105-107 (1980).

I wrote that life began—the most important event on our planet—during the Precambrian age and that H.G.Wells had in his Implacable Law defined better and more precisely than anyone else, the struggle for survival for all of us on Earth. I considered this law as a philosophical statement and a scientific cornerstone for all biological evolution. Few will recall that Wells was a biology graduate of the Royal College of Science (my own College), later on part of Imperial College, and that the first part of Wells's two-volume *Textbook of Biology* was published in 1893. It was his first book.

Did Wells ever consider how Life started on Earth? He summarily dismissed panspermia in his *Science of Life* of 1931 as "it only removes the problem of life's origin one step further back". But if life is now to continue on our planet, we must consciously learn to adapt to the ever more rapid changes which confront our survival. I have enumerated the vast problems facing us now, and in my opinion, their solution is as much a political as a scientific challenge for Interdisciplinary Wisdom. [See Title 143]

From the unicellular life of the Precambrian to the *Homo sapiens* of today, evolution has been unidirectional, to ever greater complexity, to greater gifts of thought and action. Those unable to adapt to change, perished. Evolution has always been positive, upwards and forward, true to the Implacable Law. Who gave the direction? God? Is this a proof for His existence?

I returned to "Adapt or Perish" as an Editorial in ISR, see Title 271.

Apollo 1—Disaster and Delay Title 147

By the end of 1966, the preliminary tests and preparatory space flights for the Apollo Moon program were considered satisfactory and the time had come to test the actual Apollo space capsule. The gigantic engines of the Saturn V rocket had been developed over many years under the supervision of Wernher von Braun, assembled at Michoud and had been fired from the Mississippi Test Facility. The test of the capsule itself took place at Cape Canaveral.

On Saturday 28 January 1967 I was driving from London to Manchester where I had made a number of appointments with scientific friends to write about their work. It was my habit to make occasional check-calls back to the office when on a trip, either to my secretary or to the Foreign Editor, just to be sure that nothing had happened that might require any comment from me.

I shall never forget that when I called the Foreign Editor from a call box by the road, he said: "Yesterday there was a flash fire in the Apollo capsule and the three astronauts in it were killed. Your comment is required soonest". I was dumb-struck: Mercury and Gemini had been so wonderful and now this!

I had time on my drive to collect my thoughts and on arrival in the Piccadilly Hotel I filed my story. It appeared in the Monday paper under the headline: "Major Spacecraft Changes unlikely despite Fire". The three astronauts killed were Virgil Grissom, Edward White and Roger Chaffee. On that fatal day, 27 January, they were practising launch simulation for a 14-day Earth Orbital Mission, designated AS 204. An emergency egress test from the capsule had been scheduled, but regrettably it never came to that. A sudden flash fire caused their death.

The Commission of Enquiry surmised later that a spark had occurred, but its source was never found. This must have ignited an inflammable piece of cotton waste or paper left behind by the contractors, and the pure oxygen atmosphere in the capsule led to the flash fire. My speculations from Manchester were the same, as the words 'flash fire' gave me the clue.

The important resulting changes were the substitution of a 60 % oxygen, 40 % nitrogen mixture at normal pressure in the cabin. Secondly a mechanical handling system of the emergency exit opening was installed. The final delay of the program was about threes months, as I had suggested in my story.

I sent a cable to my NASA friends: "Our thoughts are with you at this first tragedy. Remember Captain Scott's last message in the Antarctic in 1911: 'We took risks, we knew we took them. Things have come out against us, and therefore we have no cause for complaint.'"

From 25 March to 10 April 1967 I made a hectic, all-embracing tour of Israeli science, my first since I joined the *Daily Telegraph.* Much of this was very impressive, some was ordinary and although I filed a fair amount of material to the *Daily Telegraph* from Israel, very little was published. Why? There certainly was no anti-semitism from the Owner, Lord Hartwell, but perhaps some from the lower grades of the editorial staff, I do not know. Perhaps the stories I reported were not considered of prime interest for the average British reader of the newspaper, or simply because Israeli science was 'small' science.

I had a previous tour of Israeli science in 1959, eleven years after that country's Independence. From money left over from their 10th Anniversary celebrations, a number of British science writers were invited, and at that time I wrote a long editorial about my tour for *Discovery* which I then edited. [See Title 64]

My second visit was as stimulating as my first, and from the Weizmann Institute in Rehovot, we rushed east to the Dead Sea and then to Eilat by the Red Sea, north again to Jerusalem University and finally to the Technion in Haifa. I took ample notes about the scientists I met and about their research work, but my thoughts about financing Israeli science at the Weizmann Institute might prove more interesting. I recorded them there and then.

An annual budget of US $ 10 million was then required for the Institute and that was raised predominantly by volunteer contributions from abroad, mostly by American Jewish Organisations. The 'promoter extraordinary' or '*Schnorrer* ' as it is called in Yiddish, was Meyer Weisgal, originally a New York impresario who was enlisted by Chaim Weizmann himself for this all-important job. The flow of funds was naturally spasmodic and thus prevented the drawing up of any long-term scientific research plans.

Short-term loans from the U.S. Government did not prove a stable alternative, although useful stop-gaps. Scientific research cannot live on charity, I concluded. Research contracts from British Government Departments were suggested, but I was most skeptical that these would be awarded. Income might possibly be raised from Jewish Organisations in European countries, but this would require a proper 'sales staff'.

Finally, and this was the achievement of another 'promoter extraordinary' Dr Joseph Cohen, who called on German Chancellor Adenauer, and persuaded him to support the Institute. By 1956 a German scientific delegation from the Max-Planck-Society, composed of Otto Hahn and Wolfgang Gentner, among others, visited Israel and thus initiated stable German financial support.

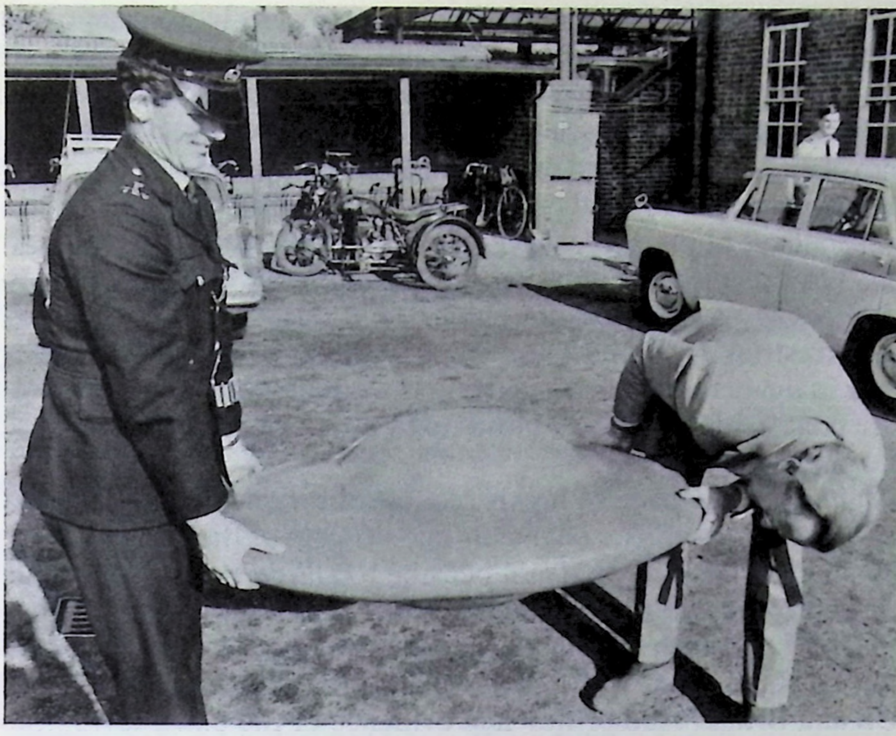
For a Science Correspondent, each assignment is new and offers a challenge, nothing is repetitive. Only on a very rare occasion can previous experience help. This happened when a brand-new American research ship, the *Oceanographer*, 3800 tons, passed through the English Channel on her maiden voyage of which I had previous knowledge. I was determined to repeat my successful scoop of the *N. S. Savannah.* [See Title 90] I again telephoned the Captain while crossing the Atlantic. He suggested a rendezvous, at 49° 50' N and 05° 30' W, about 50 km south off Penzance in the English Channel at 02.15 hours on 19 April 1967. But how was I to meet this location? I had grave doubts that any of the normal fishing boats in Newlyn, the nearby port, which I might have chartered, would have the skill to find the precise coordinates at sea, possibly during a stormy night.

I was fortunate that during my holidays in Penzance in Cornwall, I had met the Captain of *T.H.V. Stella*. She is a Trinity House Vessel whose duties are to supervise the buoys at the entrance to the British Channel and to refurbish the lighthouses along that dangerous coast. I had on previous occasions written and published about her work and had been invited to lunch by the 'Elder Brethren' of Trinity House, the Master Mariner Board of Directors of the British Lighthouse Authority and the owners of the *Stella*. I approached them officially and asked if the *Daily Telegraph* could charter the *Stella* for my rendezvous. The answer was a polite "No, this was not possible under their statutes. But if I told the Captain of the coordinates of the rendezvous, he would have the permission of the Board to deliver me there."

Naturally I was excited, and full of confidence that the Officers of the *Stella* would find the correct location, and I was not disappointed when I boarded the *Oceanographer* punctually at 02.30 hours on that historic morning. However what surprised me most was, when stepping on board, that an officer met me with a complete Press Kit and photographs—another example of the American 'Open Information Policy' for the Press. [See Title 107]

The *Oceanographer* was completely automated, and had, as the first civilian ship, Satellite Navigation which she used to cross the Atlantic. Vice-Admiral H. Karo, the Director of the Expedition, briefed me on the many electronic and satellite aids of a modern oceanographic research vessel, belonging to the United States Coast and Geodetic Survey. As the first of her kind, she had a large computer on board, automatic picture reception and transmission by satellite for global weather reports, three echo sounding and one gravity meter, as well as 137 sensor systems. When we reached Plymouth, my story was ready and published with pictures of the electronic equipment taken by a staff photographer who came aboard at Plymouth.

See Watercolour Title 149, inside Front Cover



Title 150

On 4 September 1976 the Author (right) was called by London's Metropolitan Police to their Bromley Station in South London to inspect a UFO, handed to them by a member of the public. It was of course a hoax, well made from terrestrial wood and plastic. *Courtesy Daily Telegraph.*

UFO—Unidentified but Undeniable Title 150

UFO stands for Unidentified Flying Object, the official term for a sighting reported by the public to authority and which cannot be explained as a balloon, an aircraft or other man-made object or a naturally occurring meteorological phenomenon covered by the known physical laws of science. In the decade of the 1960s, there were many such unexplained sightings and in Britain, 56 were reported to the RAF. Careful investigation explained many and only 14 were classified as UFOs.

As Science Correspondent of the *Daily Telegraph* I was frequently asked to explain such a sighting. On a memorable occasion, 4 September 1967, I was called to the Police Station in Bromley, a south London suburb, and shown a 'flying saucer', claimed to be extra-terrestrial by its finder. Its shape was that of a double-convex lens, about one meter in diameter, made of plastic and wood, and of definitely terrestrial origin. A nice hoax, photographed in close-up by a staff photographer of the *Daily Telegraph* and published next day.

However, many sightings were made by highly reliable observers, such as aircraft pilots, civil defence personnel, scientists, engineers and officers of the Armed Services. I began to keep a file in the office, and as it became too large I wrote an article on the subject published 20 August 1966, which the Sub-Editor headlined as "Unidentified but Undeniable". I considered this an excellent conclusion to which I subscribe still today. At the time there was a large sensational literature on UFOs, claiming that the US and British 'Authorities' had evidence of the extra-terrestrial nature of UFOs but did not release it, for fear of causing panic among the public. Never did I find any evidence for these claims.

The sightings of UFOs occurred all over the World and were often strikingly similar. Observed at high altitudes from an aircraft, they appear as large white or silvery cylinders, capable of very high velocities. Nearer the ground, they looked like two saucers, placed rim to rim, radiating strong light from the periphery, changing rapidly in colour. They are always silent, sometimes they 'wobble' from left to right, or up and down, they may hover for some time at tree level and disappear with great acceleration in their flight path.

I concluded in my article that the existence of mysterious flying phenomena was undeniable, but that no valid explanation had been found by 1966, when my article was published, or since then. The appearance of UFOs, although one still hears of them very occasionally, has greatly declined in recent decades, and this is just another unexplained fact. Science has solved many mysteries of the past, and perhaps this one will also be resolved one day. No further comment!

A BBC announcement on 23 April 2001 stated that the British UFO Bureau had closed down, because there were no longer sufficient sightings to continue.

In the decade of the 1960s the sightings of UFOs reached its maximum, and at the same time the 'Cold War' was at its most intensive stage. As I was expected by the Editor of the *Daily Telegraph* to be a Science Correspondent who knows every aspect of Science, military as well as civilian, (*sic*) I collected every scrap of public information dealing with espionage and I published a summary article on 15 July 1966. I began:

> "Space spies, human and electronic, will make 007 as old-fashioned as a knight in armour ... Allen Dulles, the former head of CIA (the American Intelligence Agency) said: 'It is much easier now to put a listening device into somebody's room, than a lady spy into his bed.'"

At the time of writing, I could report that electronic micro-miniaturisation had allowed listening and transmitting devices to be hidden in a false molar tooth, in lipsticks, spectacle frames, earrings and fountain pens. Although few details were published about the information gathering capacities of American and Russian reconnaissance satellites, like Samos and Midas, their usefulness was known and generally acknowledged. The American NSA (National Security Agency) was in advance of the Russian equivalent, as it had more than 2000 listening posts distributed around the Earth and could thus obtain the results of the satellite reconnaissance continuously in real time, which the Russians could not. No doubt since 1966 much progress has been made in these fields.

I gave emphasis in my article to the advice of Admiral R.H. Hillenkoetter, who urged as long ago as 1947 that 80 percent of all intelligence should now be based on technical and scientific journals and photographs, indicating the usefulness of scientific discoveries for military purposes of the future.

Ever since I have wondered if the British MI 6, the Deuxième Bureau, the German D.N.B. and the Italian SISMI have followed Hillenkoetter's excellent advice, and how they managed to carry out a continuous, world-wide search of the scientific and technical literature for any indications of possible future weapons of war. It might just prove possible, if these Intelligence Agencies were allied in NATO and among them subdivided the whole field of science, and then exchanged their revelations. It would also be necessary in such a search to involve many university scientists to scan the scientific literature, a vast field.

Could agent 007, even if he had a degree in Physics, have warned 'M' of a possible atom bomb, after reading Otto Hahn's and Fritz Strassmann's scientific publication in the *Naturwissenschaften* of 6 January 1939 about the splitting of the uranium atom by means of neutron radiation. Barium resulted, and was this proof of atomic fission and a possible bomb? Only a few readers guessed at the time!

The American Association for the Advancement of Science, the AAAS, (referred to as the 'Triple A—S'), is the biggest meeting of scientists in the world. Annually, about 3000 to 5000 American scientists, and a few from Europe meet, lecture to each other about their latest research, and generally have a good and interesting time. The first American meeting which I attended was in 1967, and if my memory serves me right, I was also the first Science Correspondent from England who was present. Later on, many of my London colleagues followed my example, and we all met regularly in the various American cities where these mass meetings took place.

Such assemblies of scientists from different disciplines have a long tradition. The first which ever took place was in 1820 when the Gesellschaft Deutscher Naturforscher und Ärzte in Berlin was founded, followed by the British Association for the Advancement of Science in York in 1821, and in 1848 by the AAAS in Philadelphia. Many other countries have since then started their own Associations for the Advancement of Science and I have also attended the Indian Science Congress Bangalore Meeting in and the ANZAAS one in Sydney. Both were most interesting and equally fruitful.

The tradition has remained the same until the present: lectures, exhibitions and excursions, combined with large social dinners. It has contributed much to the spread of science amongst scientists and non-scientists alike. Lavish coverage, first by the press, then also radio and now television, have popularised science, frequently with great success. At these meetings new branches of science sprang up and were organised into novel, specialised scientific societies, also greatly contributing to the progress of their own science.

I became a very regular Correspondent of the American, as well as the British and German meetings. In 1967, and for a few years after that, the American Conferences took place between Christmas and the New Year, and as during those few days, little political news were offered to the *Daily Telegraph*, my science reports from the United States were readily accepted and welcomed in London and all published. The air-fare and hotel costs were never queried by a rich newspaper like mine, and I think I never disappointed the Foreign Editor, Ricky Marsh, who fully supported my many travels.

At these meetings the arrangements for the press and the other media was always good, but the AAAS excelled. Months before, a preliminary program arrived in my office, and at the meeting itself, a special officer always arranged for Press Conferences 'On the Hour, Every Hour' so that all the important lecturers could be questioned. This procedure was never followed either in Britain or in Germany, and reporting was left to the initiative of individual science correspondents.

A typical AAAS Meeting Title 153

On arriving at one of the Hilton Hotels in New York on the evening of Christmas Day 1967, a large queue at the check-in counter greeted me, all scientists coming to the AAAS Meeting. Only one of the largest hotels in New York could provide not only the many lecture rooms and halls for the meetings, but also the huge demand for hotel rooms for the visitors from all over America. It is a brilliant, and the only convenient, solution by the AAAS organisers, to combine bed-rooming, restaurants and lecture-facilities in a single building. A simple ride, in the always overcrowded elevator, allows a rapid change from listening-work in one place to refreshment or writing-work in another.

After a brief unpacking in my room, first priority always is the Press Badge. This one receives, after due accreditation, in the suite reserved for the Press where all possible additional facilities, like typewriters, telephones, fax machines and photocopiers are available. Laptop PCs are standard equipment now, but were not in 1967. Many lecturers, having no doubt learnt from experience, now provide either abstracts or full texts of their presentations in the Press Room for the benefit of the many hundred representatives of the various media. Piles of luscious publications from industrial companies are also available there from those who are in one way or another concerned with the Meeting, or in the case of a the lecturer representing a commercial firm.

Innumerable voluntary organisations, scientific and otherwise, prepare colourful sheets of paper with advertisements and with them and liberally decorate walls, columns and tables with these, until they eventually land on the floor. This gives many rooms a very pleasant and bright, though rather untidy, aspect. Every night the hotel staff clean up, so each morning presents a different, but ever new work of art to the beholder—if he has the time to look!

Quite separately, mostly deep down in the sub-basement, is the Exhibition Hall where about half the space is devoted to wall charts, explaining single pieces of research by junior scientists for comment or criticism from those inclined to show-off their own knowledge. The rest of the basement is devoted to the advertisement stands of publishers, anxious to sell and also to buy the works of authors. Laboratory equipment finds room on other stands.

I have even seen works of art in these Halls, showing for example science fiction paintings of spacecraft on new planets or sculptures inspired by mathematics. One set of sculpture I liked so much that I invited the sculptor to write a brief article about his work and published it, with photographs, in *Interdisciplinary Science Reviews*, when I was editing the Journal. There can be no doubt that a AAAS Meeting is inspiring for scientists of all disciplines, if they are willing to open their minds. [See also Titles 202-204]

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The December 1967 AAAS, being held in a Hilton Hotel in New York, gave first priority to the President of the Hilton Hotel Corporation, Mr Barron Hilton. He announced that there will be 100-room underground hotels on the Moon. Being then only 40 years of age, Mr Hilton hoped that he personally would open the first Lunar Hilton Hotel. But I was skeptical! Rightly so?

In my report in the *Daily Telegraph* on 27 December I began: "Trade will follow space exploration, as surely as trade followed the flag in the exploration of our own planet." Then I quoted Mr Hilton "If peace continues in outer space, there will be travellers, and where there are travellers there will be Hilton Hotels." Giving Mr Hilton the generous age of 'four score years and ten', by the year 2017 he may just be lucky enough to fulfil his wish.

"Human Stones" was the title of Dame Kathleen Lonsdale's "Moving Frontiers of Science" lecture, analysing the occurrence of bladder and kidney stones in men and women in various occupations in Europe and America. At the time, Dame Kathleen was one of the world's foremost crystallographers, and during many years had analysed over 1000 stones, some as old as 200 years. She had by no means found all the answers, but hoped that a slight change in secondary crystal formation would lead to a natural cure. I transmitted a report to London on this interesting subject, but it was not used.

Exobiology was in 1967 a novel scientific discipline, no doubt stimulated by the appearance of UFOs. At a crowded joint meeting of the AAAS and the American Astronomical Society, the possibility of extra-terrestrial life and various possibilities of defining 'life' itself, were hotly discussed. At that time the US Congress had cut the budget of NASA by 8% and this led to great fury among some US space scientists. They threatened to "bootleg the American space programme and join their Russian Colleagues in a joint search for extra-terrestrial life" as Dr B. Wagner of Columbia University put it.

He stated that there were then 10 million Americans convinced that UFOs were of extra-terrestrial origin, and instead of the all-too conservative American Apollo Moon program, scientists should engage in research to find a way of communicating with those from other planets, the 'proper' exobiology.

The visitors from space could then tell us how to cure cancer and how to run our political affairs. The believers were like children "who know what is in the Christmas box, because they wanted it". In Dr Wagner's opinion the subject of UFOs had led to "A constipation of thought and a diarrhoea of words". I found some of the long discussions iconoclastic, though stimulating, but the subject too novel to reach any valid conclusions. I did not report it.

The parachute of Colonel Vladimir Komarov failed to open on re-entry from space on 25 April 1967, and he died as the first man during a space flight. While still mourning the death of the Apollo 1 crew, [see Title 147] the further death of cosmonaut Komarov only three months later convinced me that deaths were inevitable in the progress of science, and I immediately wrote an article for the *Daily Telegraph* entitled "Space Martyrs". They never published it, but when I was editing *Interdiscipinary Science Reviews*, I published it as an Editorial in 1986 as a tribute to the Challenger crew whose Shuttle exploded soon after the start. [See I S R Vol 11, No 4, p. 321, 1986]

I made only one point in my article: Many had given their life to gain new knowledge, but their deaths had never discouraged other scientists from following them, to gain new knowledge and to make exploration safer. I gave many examples and started with intrepid balloonists, as for example Tissandier, Croce-Spinelli and Sivel. In 1875 they rose in their balloon *Zenith* to 8.5 km to test oxygen breathing equipment. Tissandier alone survived, later to become Editor of *La Nature.*

Among the pioneers of flight Otto Lilienthal, whose experimental glider crashed in 1896, will always be remembered. Many other early aviators paid with their lives, among them the Swedish balloonist A.S. Andrée, who tried in 1897 to reach the North Pole from Spitsbergen Also in the Arctic, William Berens died in the Arctic Ocean in 1597, Henry Hudson in 1611 and Sir John Franklin in 1847, but their deaths did not deter others who followed them. And so it was in the Antarctic, where the deaths of Captain Scott and his party in 1911 only encouraged a later generation with better techniques, like Admiral Byrd with his aircraft.

Among the land explorers was Dr Leichhardt in 1848, who tried to find the overland route across Australia, but never came back. The slow radiation death of Marie Curie in 1934 must also be a reminder that the unknown is never completely safe and that safety, even in the laboratory, must never be taken for granted. Medical researchers who tried new experiments on their own bodies learnt this lesson too late, when they exceeded the limits of safety. One of the early frogmen who paid the ultimate penalty in 1962, was Peter Small, who tried a mixed-gas atmosphere at 350 m depth off the coast of California, but never reached the surface again.

I finished with a quotation from Alfred, Lord Tennyson [1809-1892]:

> "All experience is an arch wherethro'
> Gleams that untravelled world, whose margin fades
> For ever and for ever when I move."

My fourth year as Science Correspondent, 1967, ended as successfully as the previous one. I had, however, travelled only 44 032 km (1966 101 920 km) but continued my work rate of almost one story every day. As in the past, nearly all of these were published. On analysis, the only significant difference was, that my travels were more frequently in Europe, with only a single visit to the United States.

I give again, as previously on Titles 96, 115 and 139 a selected list of titles:

ELECTRIC SPACE PROPULSION
GUIDED WEAPONS RANGE AT BENBECULA, SCOTLAND
CHINESE HYDROGEN BOMB
EARLY BIRD AS GOOD AS NEW AFTER 2 YEARS
MANKIND 2000 CONFERENCE, OSLO

TOWER OF WINDS ATHENS—DEREK PRICE
BRITISH FUEL CELL FOR APOLLO
RAF COLLEGE OF AIR WARFARE, MANBY, LINCOLNSHIRE
NORTH SEA AS SEWER
NEWSPAPERS INTO COMPUTER AGE

EXTENSIVE TESTS OF VINLAND MAP AT BRITISH MUSEUM
HOMAGE TO HOMI BHABHA AT ROYAL INSTITUTION
QUEEN INAUGURATES 98 INCH TELESCOPE
ARTHUR C. CLARKE 50TH BIRTHDAY COPPER PLAQUETTE
LONDON THAMES FLOOD DANGER

LONDON SAFE SAYS MINISTER (Retractable Flood Barrier considered)
TOUR OF GERMAN SCIENCE
BRITISH CHEMISTS WIN NOBEL PRIZE SHARE (Porter + Norrish)
MARIE CURIE 100TH BIRTHDAY CELEBRATED IN WARSAW
CHINESE HISTORY OF SCIENCE, NEEDHAM, B.A. LEEDS

'NON-FLYING SAUCER' HOAX AT BROMLEY POLICE STATION
LAW OF OECUMENOGENESIS—NEEDHAM
HELIGOLAND
ALDABRA ISLAND—ROYAL SOCIETY PROTESTS
RUSSIANS TRAIN TO END SPACE TRIPS AT SEA

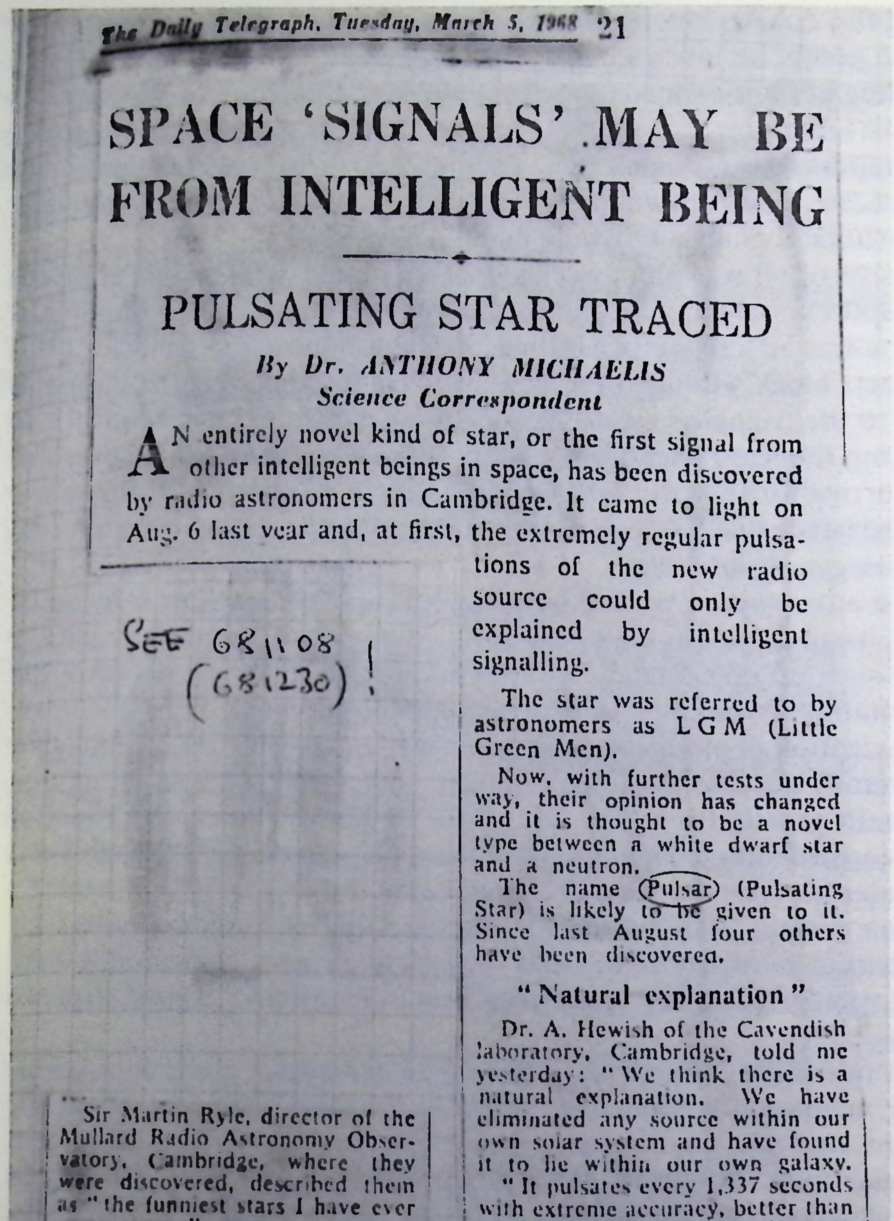
After attending the AAAS Meeting in New York at the end of December 1967, I was delighted to accept an invitation from the Honeywell Company to visit them. It meant travelling at their expense, mostly by air, from New York to Washington, then Minneapolis—their Headquarters, to Denver, Boulder, Seattle, San Diego, La Jolla (Mount Palomar), Los Angeles and back to Washington and London. I saw much of interest, made extensive notes, wrote many articles for the *Daily Telegraph*, but unfortunately only a few were published.

Most impressive of all was Honeywell's laser-gyroscope, a totally novel invention, and this report was acknowledged by the Night Editor as worthy of publication. (Perhaps he was an amateur yachtsman and hoped one day to own one!) It is a triangular quartz block with its three sides of 14 cm length having three tunnels inside, parallel to the triangle's sides. Through these miniature tunnels travel two laser beams, being reflected back from mirrors at the edges. Any minute time difference in the arrival of the two light beams is due to a deflection of the whole quartz block, and hence due to the movement of the ship, the rocket or the aircraft, in which the laser-gyro is mounted.

It has marked advantages over the normal gyroscope, being cheap as it can be mass-produced, it can deliver its digital output in figures which can be electronically used and it can start up immediately, without having to wait for the run-up of the conventional rotating gyroscopes. Called Inertial Guidance, and originally developed for the navigation of atomic submarines, it was in 1968 still too expensive for commercial aircraft, but was confidently predicted by Honeywell scientists that they would benefit greatly from their laser-gyro. Dr J.E. Kilpatrick, the leader of the design and construction team in Minneapolis, told me at the time "Reliability is the prime consideration for the whole electronic system."

At the Denver research laboratory, I was shown a novel recording system for heart beats. Whereas normally heart beats show as single lines, Honeywell's 'Visicorder' shows a vectogram, a loop of the heart beat from two sides, which will prove a great advantage.

In Seattle, Honeywell's research was focussed on underwater electronics, covering radar, sonar, echo sounders and other nautical electronic instruments. Their latest development was an 'echo-scanar', an electronic echo-sounding instrument which scans ahead and to both sides of a vessel for obstructions. Typical uses would be for locating shoals of fish, for salvage, for rescue vessels and fire-fighting boats. A new electronic underwater acoustic beam for oil-drilling ships, used on the Norwegian coast, was also shown to me.



The Daily Telegraph, Tuesday, March 5, 1968 21

SPACE 'SIGNALS' MAY BE FROM INTELLIGENT BEING

PULSATING STAR TRACED

By Dr. ANTHONY MICHAELIS
Science Correspondent

AN entirely novel kind of star, or the first signal from other intelligent beings in space, has been discovered by radio astronomers in Cambridge. It came to light on Aug. 6 last year and, at first, the extremely regular pulsations of the new radio source could only be explained by intelligent signalling.

SEE 681108 (681230)!

The star was referred to by astronomers as L G M (Little Green Men).

Now, with further tests under way, their opinion has changed and it is thought to be a novel type between a white dwarf star and a neutron.

The name Pulsar (Pulsating Star) is likely to be given to it. Since last August four others have been discovered.

"Natural explanation"

Dr. A. Hewish of the Cavendish laboratory, Cambridge, told me yesterday: "We think there is a natural explanation. We have eliminated any source within our own solar system and have found it to lie within our own galaxy.

"It pulsates every 1,337 seconds with extreme accuracy, better than one part in 10 million. Since we published the results last week I have had several telephone calls from America. I am sure that today every radio telescope is looking at the Pulsars. It is the greatest thing in radio astronomy for a long time."

Sir Martin Ryle, director of the Mullard Radio Astronomy Observatory, Cambridge, where they were discovered, described them as "the funniest stars I have ever come across."

The accurate pulsations were noticed first by Miss S. Jocelyn Bell, a Ph.D. student from Ireland working under Dr. Hewish. At the observatory at Barton, near Cambridge, I saw the interplanetary scintillation aerial, the telescope with which they were discovered.

Mr. B. Elsmore, of the observatory, said that the telescope made of thin cedar wood supports, 12ft high, containing 50 miles of wire, cost less than £1,000.

Title 158

The word "PULSAR" was invented and first appeared in print in this article of *The Daily Telegraph* on *Tuesday March 5, 1968* but the Science Correspondent did not write the headline. *Author's Collection.*

On 5 March 1968 the *Daily Telegraph* published an article under my name which was headlined: "Space 'Signals' may be from Intelligent Beings". This title was a typical example of editorial exaggeration (The titles of stories, their headlines in a newspaper, are never given by the reporters who actually write them, but by a special sub-editor who is employed just for this purpose to choose an evocative line to attract the readers' attention and curiosity).

I had visited Dr Anthony Hewish (later professor, FRS and Nobel Laureate) at the Cavendish Laboratory in Cambridge on the previous day and he told me of an entirely novel kind of star which had first been noticed on 6 August 1967. To begin with, the only explanation of the extremely regular pulsations of the star could be explained only by intelligent signalling and among themselves they called it L.G.M. (Little Green Man).

The first to notice the regularity of the pulsations was Miss S. Jocelyn Bell (later Mrs Bumell, Ph.D.) a student from Ireland working with Dr Hewish. Miss Bell told me: "We have eliminated any source within our solar system but have found it to lie within our own galaxy. It pulsates every 1.337 second with extreme accuracy, better than one part in 10 million. Since we published the result last week, Dr Hewish has had several telephone calls from America. I am sure that today every radio telescope is looking for pulsating stars. It is the greatest thing in radio astronomy for a long time" With further tests under way, the Cambridge team of radio astronomers had changed their opinion and favoured a completely natural explanation of the new star's pulsations. It might be somewhat between a dwarf star and a neutron star, was their opinion at the time.

I asked Dr Hewish "What do you propose to call this new type of star? As it pulsates" I said "would not 'pulsar' be appropriate?" He replied "Yes, that might be a good name for it". I think I was justified in my report in the *Daily Telegraph* to state in print: "The name Pulsar (Pulsating Star) is likely to be given to it"and thus the word *Pulsar* entered the literature and has always been used for this type of star. Many more stars of this kind have been discovered since then.

It was only 11 years later that I received confirmation that I had created an astronomical neologism by being the first to use the word 'pulsar' in my report in the *Daily Telegraph*. I had sent a cutting of my article of 5 March 1968 to Mrs Bumell at the Mullard Space Science Laboratory near Dorking in Surrey where she was then working and asked her for an assurance of my priority which had been doubted. She replied very kindly on 18 October 1979 "Yes, as far as I know, this was the first published use of the word pulsar".

The first ever Press Visit to the Chemical Defence Experimental Establishment—an integral Part of the British Ministry of Defence—took place on 25 May 1964 when I was still a rookie Science Correspondent of less than six months' experience. However, as a research chemist by academic discipline, I had been interested in this arcane and super-secret subject more than the majority of other scientists. I considered it as a prostitution of chemistry. It is an old experience, that the more secret a subject, the more it attracts the attention of the media.

A press visit to Porton Downs, in the peaceful rural county of Wiltshire, just north of Salisbury Plain—a traditional Army Exercise Ground—was for me a very exciting event, so early in my newspaper career. We passed through a double barbed-wire security fence into a very inconspicuous-looking area, dotted with insignificant small huts. Our group of a few London correspondents, was received by the Director, Dr E.E. Haddon and his staff.

Seated around an oval green-baize covered table, we were first treated to a general introduction of the subject, during which CS, the riot-control gas, was frequently mentioned. We were then given an interesting Table of Deadliness:

0.001	Botulin Toxin	MOST LETHAL
0.01	Snake Venom	
0.1	Curare	
1.0	Poison Gas Nerve Agents	
10.0	Mustard Gas	
100.0	Prussic Acid	LEAST LETHAL

When attention flagged and cups of coffee had reduced our group to the normal boredom of a press conference, Dr Haddon grasped a bottle standing in the middle of the table containing innocent looking white crystals and having removed the stopper, handed it round. "This is CS, perhaps you would like to have a sniff of it" he said invitingly. Most of my colleagues took him literally and sniffed the bottle with dramatic results. Their eyes began to weep copiously, their noses started to run vigorously and coughing and spluttering loudly, they used their handkerchiefs to wipe their faces.

Having had years of experience as an organic chemist, I wafted my hand over the suspicious bottle and thus received only a small trace of a smell. I fortunately escaped the worst of this unprovoked poison attack, although my eyes watered. All boredom had disappeared, and our respect for the subject was restored. But my interest in it had turned sour after, what I considered, a 'dirty trick'.

C B W — Visit to Porton, Discovery of Nancekuke Title 160

A four hour tour of the Chemical Defence Experimental Establishment at Porton followed the dramatic demonstration of CS. Chemically, we were told, CS is osmi-cron-chloro-benzylidine-malonitrile, originally discovered in America, but greatly improved by chemists at Porton. Its production and use were covered by British Patent Number 967 660, entitled "Improvement in Apparatus for controlling Riots" of 14 November 1960. Standard issue to the British Army but not the Police, CS is synthesised in the UK, exported and employed world-wide, as for example in the Vietnam War. The owner of the patent was the British Ministry of Defence, which apparently found it a profitable export item and received royalties from its patent before it expired.

Our tour in 1964 of the microbiological and chemical divisions at Porton covered seven laboratories, 30 minutes for each scheduled, where we saw only standard laboratory equipment. It was obvious that our visit was 'a carefully laid on demonstration' as I noted at the time. Our queries were frequently answered with: "I am not allowed to answer your question". No possible spy among our group could have learnt anything of value and I decided that nothing I had heard or seen, would interest any reader of the *Daily Telegraph.*

It was four years after the first press visit to Porton, on 22 July 1968, that the *Daily Telegraph* had another of my stories on this subject "Poison Gas Disaster Fear in Cornwall". During my regular holidays in Cornwall I had met local inhabitants and one of them pointed me to a security area at Nancekuke Common. I checked the excellent library of the *Daily Telegraph,* but nothing was known about the place nor of any secret activities there. My scoop!

Nancekuke proved to be the 5000-acre outstation of the Chemical Defence Experimental Establishment of Porton, roughly extending between Porthreath to Porthtowan on the North Coast of Cornwall. It was surrounded by a high security fence with many notices "Official Secrets Act—Prohibited Area" and it was this which naturally raised fear among the locals, depending on the summer tourist trade for much of their income. I drove in my Land Rover along the road from Porthreath to Porthtowan and through the hedges I could clearly see what looked like a large chemical plant with a high white chimney, which I estimated as 75 m high. In my article, the first ever press report about Nancekuke, I stated that the outstation was being used for manufacture and for field trials on animals and human volunteers.

Three days later, a letter was published in my newspaper by the Chemical Director of Porton, G.N. Gadsby, stating that no field trials had ever taken place at Nancekuke and no accidents had occurred during the last 12 years. It was therefore a well guarded, long established and secret production plant.

C B W—Running Story of Green Monkeys Title 161

My report about the industrial chemical plant at Nancekuke, undoubtedly producing CS gas and other secret war materials, was the first ever to appear in the press, and thus might well have given an enemy of Britain, at the time the Soviet Union, an additional target for aerial bombardment, if they had not already known about it. No general censorship of the British Press existed at the time, and my only obligation was to submit any doubtful material I wrote to a special Advisory Committee, if and when I thought that my writing would threaten national security. The chemical plant at Nancekuke, in existence at least since 1956, did not qualify. I did not have it checked by the Committee.

The Nancekuke story which appeared in the paper on 22 July 1968 was not my last article on the subject of biological and chemical warfare, CBW, which had suddenly become 'News'. On 7 June I had reported on my second visit to Porton, 4 years after the first, and it was headlined "Army Protection for Germ Warfare Centre". Hostile demonstrations from students of Southampton University were expected, but nothing happened.

On my second visit I was given a list of the names of the 23 British university professors, including six FRS, who were acting as scientific advisors to the Chemical Defence Establishment at Porton. This was following USA practice, where the authorities had also failed to recruit top scientists for CBW and had therefore contracted out to Universities some of the vital basic science research for CBW. I had written about this, but it was never published.

Similarly, my review of the BBC Programme "A Plague on your Children" broadcast on 6 June, stating that TV cameras had for the first time been allowed inside Porton security fence, was not published. However, a comment by an American General during the BBC programme, that Britain was "Open to Gas and Germ Attack", because of the prevailing western winds over the Island, appeared in the newspaper on 7 June.

CBW had become a 'running story' with new facts being revealed constantly. On 10 June I wrote that "Porton Scientists use 85000 Animals a Year". In the same published article I told the story of the 'Green Monkey' virus, a killer disease—as deadly as the notorious *Ebola virus*—which had been traced by the Microbiological Division of Porton and thus underlined the close link between offence and defence in this kind of research. All animals used, from mice to horses, were bred on a special farm inside the security fence. A year earlier, seven deaths and 30 cases of severe illness had occurred among research workers and hospital staff in Marburg, Germany, who had worked with green, virus infected, monkeys from Africa, which had arrived in animal cages at Heathrow Airport, London. After identification, the new deadly virus has been called the *Marburg virus.*

Like so many other inventions forecast in science fiction, Chemical and Biological Warfare was also predicted, first by Albert Robida (1848-1926) in his classic book *La Guerre au Vingtième Siècle,* published 1887 and republished 1991 in Paris by Librairie Jules Tallandier. After a description of tank warfare, and later also of underwater battles, his fourth chapter is devoted to '*Le Corps médical offensif*' (!) a dramatic, accurate and fully illustrated by the author, anticipation of chemical and biological warfare. Gas masks are worn by soldiers, diseases spread in the enemy's ranks, and the methods of distribution were described and illustrated by Robida.

In comparison, "The Stolen Bacillus" (1895) by H.G. Wells (1866-1946) was a very minor terrorist act. In this short story an anarchist tries to steal cholera bacilli from a bacteriologist to poison London's water supply, but by mistake is given a different one. One would have thought that once chemical warfare had been forecast by Robida, it would be used, as it is so easy to carry out. Fritz Haber was the first (1868-1934) to prove this during World War I, when he turned a few taps. to open a small number of chlorine gas cylinders in 1915.

At a London Conference about CBW in February 1968, Lord Ritchie-Calder revealed that during World War II Britain had developed a special strain of *Clostridium botulinum bacterium*, referred to as the 'Doomsday Bug'. It was designed to retaliate, if Hitler had used bacteriological warfare. But it was also important to inform the Germans of this fact, and therefore a few selected Canadian soldiers were instructed, if captured, to reveal that they had been inoculated against botulin. "It seemed to work" said Lord Ritchie-Calder "and Germany never used bacteriological warfare." My report about the Conference was published in full.

As far as I can trace now, that was the beginning of the running story about CBW which swept the British Press at the beginning of 1968. *We all fall down* was the title of a book by Robin Clark, the Editor of *Science Journal*, which was published in May and kept the story going. I was attracted by the book and gave it a full review in the *Daily Telegraph*. A sub-editor gave it the irrelevant title "When the Scientist goes to War".

The horror of CBW and the antipathy to those working on the subject arise from the reversal of all the basic concepts of 'medicine and science for the benefit of mankind'. The Scientific Temper aims at the benefit of mankind! Yet statistics from World War I can be quoted, proving that at least chemical warfare is more humane than bullets and missiles. Then a quarter of all American war casualties were caused by gas, but only 2 % did not survive, whereas 26 % of the non-gas casualties died. The life-long suffering of gas casualties was not included in these statistics.

'To reach the stars is one of the oldest dreams of mankind'. I often began an essay with these words. So for example when I exhibited 36 selenographic items from my Moon Collection at the Library of the University of Houston, Texas, in April 1973, I wrote a few paragraphs as a preface to my Catalogue:

> "I am also deeply conscious of the fact that without the writers of imaginary Moon voyages, first Lucian of Samosata, then Bishop Wilkins, later Jules Verne and H.G. Wells, and more recently Arthur C. Clarke, man's age-old dream of reaching the stars—via the Moon's stepping stone—might have faded many centuries ago"

The story of man's first landing on the Moon, the story of the 17 Apollo spacecraft, is indeed a Saga, a story of heroic achievement and marvellous adventure, the greatest yet in all human history. It was my much-envied privilege to report it all in some detail, from Cape Kennedy, from Houston and if unavoidable, from London, as Science Correspondent of the *Daily Telegraph*.

I began with the tragedy of Apollo 1 in January 1967 [see Title 147] through to its triumph in July 1969 of the first landing of man on the Moon [see Title 182], and to its lingering death in December 1972 [see Title 242]. My reports were always prominently displayed on the top of the page, if not on the front page, of the *Daily Telegraph.*

As I was considered the Apollo expert by the various Editors of the newspaper I had to brief myself, with the aid of voluminous reports, provided by NASA and the industrial manufacturers of the Apollo components, so that I could write at once, simply and intelligently, about any possible mishap during the progress of the Saga. When Apollo 13 was in serious trouble, "Houston, we have a problem", the classic phrase, [See Title 207] I myself was also in trouble, in a London Hospital after a hernia operation. However I had to, and was able to fulfil my duties easily. I watched the unfolding of the potential catastrophe on BBC television from my bed, wrote my comment in the afternoon, and then telephoned it through to the copytaker in Fleet Street.

My efforts were appreciated and I received a £ 100 pound sterling bonus, the only one during 10 years on the staff.

One further preliminary comment: Why did the Americans succeed when the Russians failed? The answer was spelled out in full in a contribution entitled "The Apollo Tradition" in *Interdisciplinary Science Reviews* Vol. 2, No. 4, p. 270, (1977) by Robert T. Seamans and Frederick I. Ordway. [See Title 273] They summarised the reasons for the Apollo success in a Table which follows, listing the 13 shared characteristics, which are of course only possible in a free and democratic society like the USA.

Shared Characteristics of a large Size Enterprise Title 164

For a full discussion of this important contribution to *Interdisciplinary Science Reviews*, ISR 2/4 in December 1973 see **Title 273 *Apollo Management Lessons***

Interdisciplinary Character

Array of scientific, technological, social, political and other personalities and resources brought into play, requiring regular crossing of disciplinary lines and mixing of individuals who would normally have no professional contact.

'State-of-the-art'

The basic science and technology involved are generally quite well developed, and thus do not have to be pushed excessively to justify program. But, appropriate elements of existing science and technology must be brought together, uncertainties impeding implementation removed, upgrading and focusing carried out, and results integrated into goal-oriented program that meets desired social, political, economic, military or other need.[3]

Selling

Promoters must demonstrate to potential sponsors how proposed endeavor can fulfill whatever need, ambition, or opportunity that may be addressed. Clear grasp of program content, time needed for accomplishment, and funding required is essential.

Funding

Adequate funding absolute requirement; moreover, it must be assured not only in crucial start-up phase, but over the lifetime of enterprise. Many aspiring programs commence life with adequate financial resources only to find them withdrawn when support vanishes.

Support

Having been 'bought' and provided with the needed resources, large-scale endeavor must be assured of *continuous* support. If troubled by constant exposure and repeated rejustifications, it may lose vital momentum and sense of urgency. No other shared characteristic of large-scale endeavors is so important not only at outset of activities, but all way through to successful completion.

Manpower

Large numbers of exceptionally well-qualified and highly motivated individuals are required to provide reserves in the event that unexpected problems or setbacks occur.

Planning and Analysis

Ordered, structured, precisely preplanned solutions to problems can rarely be counted upon in the large-scale enterprise, which may be very long in developing and which may involve many areas where knowledge is still hazy. Constraints and forces change continuously, new facts and discoveries must be accommodated, and the balance of organizational power may undergo significant shifts from time initial goal is articulated to time it is finally reached. Constant reassessment and redirection, therefore, are normal to planning and analysis process.

Communicating Information

Not only must vast quantities of data be made available upon demand to decision-makers at all levels of management, but widely-scattered field and contractor networks must be knit together through communications if they are to function effectively as an integrated force.

Visibility

To gain and maintain support, large-scale enterprise must be kept 'visible'[4] and hence subject to almost endless public scrutiny and legislative review. Visibility has advantages in that it tends to make organizational elements and individuals react to problems they might otherwise be tempted to ignore. This is particularly true when sheer organizational size inhibits flow of information and where problems may become magnified as their effects ripple throughout the endeavor. By maintaining visibility, strong motivations are created to solve problems rather than avoid them.

Decentralization

Because of complexity of large-scale enterprise, management must contemplate a significant degree of decentralization in decision making and in project execution. No single individual or even small group of individuals can possibly cope with all relevant facts and issues.

Flexibility

Management must continually adapt and reorganize in the face of changing pressures, priorities, restraints, policies, developments, budgets, manpower and general support. This helps insure ability of enterprise to recover if things go wrong, if support suddenly evaporates in one sector or another, or if major contractor fails to deliver on time or within established specifications.

Control and Integration

Despite need for flexibility and some degree of organizational autonomy, diverse elements that make up large-scale endeavor must be carefully controlled and integrated.[a]

Risk and Uncertainty

Some failures are to be expected along the complex research, development, and demonstration route towards a workable, reliable, on-line technological system.

Very large engineering projects were nothing new to the United States, when President John F. Kennedy addressed Congress on 25 May 1961:

> "I believe that this Nation should commit itself to achieving the goal before this decade is out, of landing a man on the Moon and returning him safely to Earth"

Previous examples of American macro-engineering were the Panama Canal in 1915, the Tennessee Valley Authority in the 1930s, and the Manhattan District Engineering Project (the atom bomb) in the 1940s. Surpassing all these, Apollo was the greatest, combining scientific, technological and managerial efforts of a hitherto unknown magnitude with a spirit of invention by all, to achieve the goal within the set financial limits and time frame. It was a triumph of the Scientific Temper.

My first impression of the sheer scale and size of the Apollo programme was when I was on a VIP helicopter tour of Cape Canaveral in January 1964 (see Title 89). My pilot hovered at about 165 meter above the virgin ground and said: "We are now at the height of the Vertical Assembly Building in which the Moon rocket will be put together." I saw nothing at the time, but on my next visit to the Cape, 18 months later, there it stood, 160 m high, 218 m long and 158 m wide, then the largest building on Earth, erected in 16 months. I was astounded and greatly impressed.

In the following four years, from 1965 to 1969, when Apollo 11 landed with Armstrong and Aldrin on *Mare Tranquilitatis*, my admiration grew and grew, as I began to appreciate the complexity and interdisciplinarity of the many sciences essential for the success of the enterprise. To state but one completely unknown parameter, it was essential to measure the strength of the lunar soil to support the heavy landing capsule. Two entirely independent spacecraft, Ranger and Surveyor and their many flights to the Moon were mandatory to measure this unknown, but essential factor.

On each of my many visits to the 'Cape', I learnt new facts and gained greater familiarity with the whole project. The sheer size of the Saturn V rocket, standing 110 m high, as tall as St Paul's Cathedral in London, whether it was inside or outside the Vertical Assembly Building, was breathtaking. Later when I was able to have a close look at one of the five F1 rocket engines, 4 m in diameter and each consuming 3 tonnes of liquid hydrogen fuel per second, I stood in awe of the gigantic engineering achievement, dictated by the mathematical calculations on which everything must have been based.

With even a little imagination I was able to comprehend the years of mathematical computer-slogging which had been done to accomplish this macro-engineering feat.

See Watercolour Title 165, inside Front Cover

Of the millions of technical components which all had to perform in perfect working order, so as to ensure a safe landing on the Moon, I can only record a few here, which particularly impressed me. At the 'Cape' itself, there was the unforgettable 'crawler', a gigantic moving platform to transport—in its vertical position—the completely assembled Saturn V rocket with its attached, 'umbilical' tower, serving as essential support and as a fuel pipe.

Inside the VAB, all rocket components were erected, one on top of another, and in this vertical position had to be moved, on the crawler, proceeding at walking pace, to the launch site, 5.6 km away. To do this, two 2750 horse power diesel generators produced electricity to drive 16 electric motors which in turn moved four huge First-World-War tanks under the corners of the crawler. It weighed almost 3000 tons and was able carry a load of 5900 tons. It was an almost outrageous concept to let sensors keep the 110 m tall rocket perfectly vertical and move it in that position over several kilometers. But the engineering genius of its designers made it work perfectly, as the whole world was able to see on television.

Even more impressive—with imagination—was the large amount of computer-crunching that lay behind the many stages of each Apollo voyage. From launch to splash-down, which took up to 12 days, there were 16 crucial points where decisions had to be made, commands to be issued from Mission Control in Houston to the spacecraft, where they had to be executed correctly to the second, absolutely essential to keep the spacecraft on its true flight-path over more than 400000 km from Earth to Moon, and back. Very large computers were needed in the 1960s to calculate orbital corrections, too heavy to carry aboard. Only simple calculations were possible on the spacecraft.

The third and most admirable triumph was the human performance of all astronauts, at least during their active service with NASA. The only astronaut whom I personally knew well was Michael Collins of Apollo 11. After his service with NASA, he was appointed Director of the National Air and Space Museum in Washington where I often met him and liked, respected and admired him sufficiently to invite him to join the Editorial Board of ISR.

As a general comment on the Homeric crew of Apollo astronauts: They behaved in "Triumph and Disaster" as Officers and Gentlemen—which they were—selected from the hundreds of applicants, predominantly from the officer corps of the American Navy, Army and Air Force. Many had scientific degrees, all were male and white. Destined to become heroes, they played their role perfectly, whatever they may have thought and felt during the tedious press conferences, during their White House visits, World Tour and all-too-rare Ticker-Tape parades in New York.

So far I have only indicated a few steps in the general history of Apollo, but the detailed history of Apollo 2, Apollo 3, and Apollo 4, the first Saturn V launch in November 1967, must be read elsewhere. Here I want to write about my own contacts with the Apollo Saga and how I was able to report them to the *Daily Telegraph*.

Apollo 6 was launched on 4 April 1968 as a dress rehearsal, but it proved unsuccessful as a number of rocket engines on the three stages did not fire properly. I was told about their malfunction late in the afternoon of 4 April, and I filed my comment a few hours later, at 19.25 as my diary record shows.

I concluded that only components had failed, and that no basic design mistake was discovered—hence no postponement of manned flight was envisaged.

Two months later, on 5 June 1968, the manufacturers of the Apollo 7 space-craft issued some striking photographs which were received at the *Daily Telegraph* picture desk in Fleet Street, and I was called to comment. On my last visit to the manufacturers I had seen 15 of these Command Modules, CM, and was then told: "One of these will go to the Moon". Probably it was not the one, published full-page in the first edition of the paper—even the final edition had a smaller picture and my comment. Apollo 7 was launched on 11 October and was the first to carry a crew of three astronauts. "All tests were Go" as it was stated in NASA-ese language.

Apollo 8, 21-27 December 1968, was the first flight to escape Earth gravity, to the Moon and around it. It was reported by 1500 news representatives, and the excellent photographs of the Earth and the Moon, caused a sensation. It was claimed later that these were the beginning of the mass environmental concern for our own, the 'blue' planet, and of the 'green movement' by the millions who saw the whole Earth for the first time—live on television.

Frank Borman, the commander of this flight, read a Bible text during Christmas Day, also televised live, which made a deep impression, as he urged "Peace on Earth". I had the run of the paper every day, with a full page of photographs, flight diagrams, television schedules and text. It was Apollo 8 that foretold the worldwide interest and the success of Apollo 11.

Title 168

After 1968, it was customary for British Science Correspondents to Visit German scientific establishments in various parts of Germany – always a very pleasant occasion. This was due to the efficient planning by the Science Counsellors of the German Embassy in London and by Internationes in Germany, which always prepared the detailed infrastructure of these events. This photograph was taken at a historical place with the Berlin Wall still in front of the Brandenburg Gate on 27 May 1963.
From left to right: Unrecorded member of Internationes. David Wilson, Science BBC; Mary Goldring, *The Economist*; Anthony Smith, Science Correspondent *Daily Telegraph*; the Author; John Davy, Science Correspondent, *The Observer. (Courtesy Internationes)*

From October 1968 onwards it became a pleasant routine from time to time to visit West-German scientific institutions at the invitation of the West German Federal Republic. Their press department had previously organised many visits for political press journalists from Britain and other European countries, but science writers were a new breed. Carefully planned in close consultation with the science counsellor at the German Embassy in London, they proved not only very instructive, but also comfortable, not to say luxurious, when compared with such visits to some other countries. At least that was my impression, as I re-discovered Germany as a normal civilised country 23 years after the end of World War II.

Our first stop on the 1968 tour was at IABG, the Industrie Anlagen Betriebs Gesellschaft, the cover name of a Central Testing Facility for the German Defence Industry in Ottobrunn, near Munich. It was owned 75 % by Government and 25 % by industry and, not surprisingly, most work concerned air and space developments.

As a matter of fact this German visit was mostly devoted to these air and space subjects, particularly so our stay in Stuttgart at the main German research institute for air and space. The range of research projects was most impressive, from electron space propulsion and exotic fuels, like fluorine for rockets, to geodetic fibre structures, produced from unusual chemical elements like boron and beryllium.

The climax of the visit was a lengthy briefing for us by Dr Gerhard Stoltenberg, the German Federal Minister for scientific research at his Bonn Ministry. I met him on numerous occasions in Germany and Britain and listened to many of his official and unofficial statements. I was amazed by his ability to master scientific subjects, speaking equally clearly and convincingly about cancer virus or interdisciplinary research, in German or in English. Such a superb Minister for science with Cabinet rank was sorely missed in Britain at the time.

I wrote a long report about his Bonn talk, which was at the same time a summary of our German visit. It was published in the *Sunday Telegraph* under the headline "Germany steps up Space Research".

Never before, and never since, have I travel 181 000 km in one year. While working for the *Daily Telegraph* in 1969, almost every month brought an overseas tour, beginning in January with an invitation by the South African (Apartheid) Government to report on their scientific achievements and lecture to their senior scientists on science writing for popular understanding. February and March sent me to the USA, to New York, then the 'Cape' and Houston, Texas, to cover the Apollo 9 flight and testing the Lunar Module LM in Earth Orbit. In May I was in Prague to report on the 12th Annual Space Science Conference.

In July I was again in the USA, the 'Cape' and Houston, Texas, for the unforgettable Apollo 11 first landing of men on the Moon. In October I started on another memorable voyage, to the South Pole, 90° South. To get there, I flew by a commercial air line from London to Washington DC, and then onwards by US Military Air Command, as their guest, to the South Pole by way of Christchurch, New Zealand, where a delay of one month occurred. [See Title 188 onwards for details]. I used this interval to visit a British mining enterprise in the York Peninsula in the northernmost part of Queensland, Australia. There and back, nearly 10000 km, see Title 192.

After this sidestep, reported to, but never published in the *Daily Telegraph*, back to Christchurch, where all was ready by then for the flight to the American Base McMurdo on the Antarctic Continent. From there it was only few hours flying to the South Pole, but numerous other flights in the Antarctic followed, to the Byrd Station and many test flights for the new British radar ice-thickness measuring equipment. [See Title 201] I filed numerous reports about my Antarctic voyage to Fleet Street, most of which were published, with one notable exception [see Title 200].

By Christmas I was back in the USA, in Boston, where the American Association for the Advancement of Science was holding its 136th Meeting. I returned to London on 3 January 1970, the end of a veritable *Annus mirabilis.*

Of course much of the year saw me in my office in Fleet street, writing about routine science every day. Here are some of the titles:

Pulsars slowing down
Russian science delays
Russia to double caviar output
Home made atom bomb impossible says UKAEA
British Metrication Forecast—ex Exeter BA
Underwater Kon-Tiki completed [see Title 185]
Defoliants condemned

The South African (Apartheid) Government had decided to invite a London science correspondent for a VIP visit to their country at the end of 1968, and their choice had fallen on me. I can only speculate why I was chosen, perhaps because the *Daily Telegraph*, well known for its conservative policy, would publish only a very favourable report. I have explained my personal attitude to politics on Title 145 as a progressive liberal, and could therefore not agree with apartheid under any circumstances. Yet I accepted the invitation after discussing it with the Foreign Editor, Mr Ricky Marsh. He left the decision to me and as a result, scientific curiosity prevailed, my Temper!

I arrived in Pretoria, the capital, on 12 January 1969. At Heathrow Airport in London, BOAC, the British airline, had placed a coloured stewardess at the check-in gate and I wondered if this was intentional. At London Customs control I was informed that the magazine *Playboy* was considered as pornographic in South Africa and would be confiscated. I had never owned a copy. In South Africa I was often reminded of Huxley's *Brave New World* with its class distinctions of all blacks as gamma and delta races, the lowest in the prevailing hierarchy.

There was no television in South Africa in 1969, the official reason being given to me was that broadcasting would be too difficult in the three languages of Afrikaans, English and Bantu, the term used for all black Africans. I was also amazed to find Yale locks on many cupboards in Hotels.

In Pretoria I met high civil servants, most of them dressed in formal black suits, although there was a local heat wave of 35 °C. Only a few wore the sensible safari suits. All private cars were driven by whites, except when they had a black chauffeur, whereas Bantus were walking. Taxis and lifts had prominent signs "Whites only".

I found the semi-tropical flora reminiscent of Australia with eucalyptus trees everywhere and the same garden shrubs with their lusciously coloured flowers. The bungalows were also much alike in both countries, and so was the general absence of any books in them. At night, after 23 hours, Pretoria was deserted, as Bantus had to return to their 'Home Towns', but I was assured "We have of course no curfew in South Africa".

During my first working day in South Africa, I was driven 30 km west to Pelindaba, the National Nuclear Research Institute. Compared to Los Alamos in the USA, Harwell in Britain, Trombay in India and Jülich in Germany – all of which I had visited – it was of course much smaller and less sophisticated, as I had expected. I had a long and friendly talk with Dr W. Grant, the Director of the Atomic Energy Board, who assured me that South Africa was only interested in peaceful uses, and that it had no collaboration with West Germany for the production of a bomb, as had been alleged by East German sources.

I made this statement the opening line in my report to my newspaper, but it was not published. A novel method of producing uranium as a by-product of gold-mining was news to me. There were no Bantus at the Institute, the reason being, as I was told, that it would be too expensive to duplicate all facilities; I suspected however that security and the lack of suitably qualified Bantu scientists was the true reason.

The following day I was the guest of the Council of Scientific and Industrial Research, the CSIR, which showed me their Nutritional, Building and Sewage Research Departments. The study of heart diseases in baboons, treating them to a diet similar to 'white executives', I thought might have made a short paragraph in my newspaper. I reported it but again it was not published. A similar fate awaited my story concerning a novel sewage treatment, which I found interesting. It had been invented by Dr G.J. Stander and called after him. I saw his pilot plant in which he removed detergents, ammonia stripped the sewage, employed activated carbon and finally chlorinated it. I tried the result and the water tasted fine. I was not given any financial figures comparing it with more established, conventional sewage works.

A visit to a typical Bantu town, Ga-Rankuwa – meaning 'Going Home' concluded the day. It was scientifically designed, I was told, with a minimum of mass-produced housing. This story was published a month later. I described the liquor store and entered three houses, one very clean and well kept, one with a filthy kitchen and one with a spotless one. I could not draw any statistical conclusions from these three visits.

More than 50000 people lived in this town, and it was hoped to build 134 similar Bantu suburts in the future. As the one I saw was only 35 km from Pretoria, I suspected it to be a prestige showplace for foreign visitors.

I spent a most interesting and pleasant weekend at South Africa's major wild life reserve, named after the country's hero, Paul Kruger (1825-1904). It encloses nearly 20 000 square kilometer and is 320 km long with parts dating back to the end of the 19th century. I was driven to Olifant Camp in the centre of the Park where a small round hut had been reserved and where lunch awaited me.

The temperature was 33 °C and on the way there I had already seen many wild animals, which I recorded at the time. I saw a Batelaur eagle, waterbucks with 'white lavatory seats', a herd of impalas and one of 10 elephants which crossed the tarred road behind our Landrover. Most of the animals were quite near the road standing in the shade under trees. There was also a lone giraffe, some zebras and an old lonely baboon, sitting on a tree stump. I certainly could not complain about the variety which greeted me.

At the camp I was welcomed by Mr H. Griesel, one of the 15 game rangers, an ex-biology teacher and now an educational officer of the Park Board. After lunch and a siesta, he showed me a film as an introduction and then told me for several hours about his own research of recording animal sounds in the wild. He had discovered the ways in which lions communicated and I listened to many interesting recordings he had made.

The very excellent water conditions in the Park, rivers and full reservoirs, led to a population explosion among elephants, I was told. Hundreds of elephants had been attracted from neighbouring Mozambique to the Kruger Park. By measuring the water level in one reservoir, Griesel had found that one male elephant drank about 285 litres of water in 24 hours. As result of such high water consumption by the ever increasing elephant herds, many other animals went short of water and, if this state of affairs was left unchanged, the Kruger Park would soon become a pure elephant park.

As elephants have no natural enemies except men and disease, the question of controlled culling was being seriously considered at the time of my visit. Although poaching for ivory was reducing their numbers, neither this solution nor culling were acceptable. As far as I know, this situation has not changed at the time of revising these lines, in the year 2001.

Perhaps because of its somewhat dangerous nature, I shall never forget my descent to a depth of 3287 meter into one of South Africa's deepest gold mines, the East Rand Proprietary Mine. I had come to see where the first naturally occurring neutrino had been found. I was accompanied by Professor J.P.S. Sellschop, the discoverer of the neutrinos, and hence we were given all necessary priority on our descent, supervised by the General Manager of the mine. The first 1200 meter were in a standard mine hoist down a vertical shaft, but then we had to transfer to three consecutive small cages, rattling down inclined slopes in total darkness and sinking at a breath-taking speed.

At every transfer, a crowd of waiting black miners were pushed aside to give us an empty cage—'whites only' was the policy here as everywhere else in South Africa. It was not stated in the mine, it was natural for our VIP party. With all our priority it took us more than 30 minutes to reach the bottom. A normal miner takes one hour for the descent, a time for which he is not paid.

At the lowest level, where it was relatively quiet after the very noisy cages, Professor Sellschop told me that he had there measured a temperature of 60 °C at which any human labour would be impossible without refrigeration of the ambient air which brought it down to a comfortable 33 °C. This I measured myself on my own small portable thermometer. A long tunnel, hewn out of solid rock especially for the neutrino experiments, housed a small wooden hut for conventional electronic equipment to monitor and count the neutrinos. This hut had additional air-conditioning equipment, reducing the temperature again to only 22 °C, cold for me, but essential for the electronic instruments.

In the tunnel I saw the 4 meter long glass scintillation counters, arranged in various geometrical patterns, occupying most of the tunnel. I cannot remember now if I was told how these long glass cylinders had been transported to their position, but it could not have been an easy task. In these tubes, filled with carbon tetrachloride, neutrinos filtered from other radiation particles by the 3 km thick rock above, produced muons which can be counted and it was thus that on 23 February 1965, as a bronze plaque on the wall reminded one, the first neutrino in nature was discovered at this very spot.

After inspecting the neutrino experiment, I crawled to the one-meter high rock-face, where African miners free the gold containing conglomerate from the rock for a 6 shilling daily pay— a miserable wage indeed at whatever currency conversion rate was applied at the time of my visit. At these great depths, there is also the constant danger of pressure bursts which kill each year 25 to 30 miners in this one mine alone. However, smoking is permitted and I could puff my cigar in the deepest laboratory of the world! My story was published a few days later in London.

After my memorable 3-km descent to the deepest laboratory on earth, 80 km south of Johannesburg, I visited the Research Laboratory of the Consolidated Diamond Mines. There another science fiction forecast had come true. As H.G. Wells had predicted in his short story "The Diamond Maker" at the beginning of the 20th century, artificial diamonds were shown to me, made at a temperature of 1500 °C and at a pressure of 80000 atmospheres. They were small, yellow and destined for the industrial market.

My next visit was to the Royal Observatory in Cape Town, which in 1969 was almost 150 years old and had been Britain's major contribution to astronomy in the Southern Hemisphere. There I learnt the sad fact that Britain had switched support for astronomy in the Southern Hemisphere from South Africa to Australia and that in consequence both the Astronomer Royal at the Cape and his Chief Assistant had left. I was sorry that I had to report the end of this long tradition, and my story was promptly published in London.

My next port of call was Durban on the east coast where I interviewed Dr Christiaan Barnard, the pioneer of heart transplant surgery in his exceptionally sparsely furnished office. He had been working lately on an electrically driven artificial heart and he told me: "I don't believe that in 1969 we can go to the Moon (before Apollo 11 had succeeded) and not make an artificial heart". I was pleased that my interview was not only published in the *Daily Telegraph* but also in the *Daily News,* Durban.

As a result, a reporter from the *Daily News* came to see me and it was I who was interviewed, above all, about television in South Africa. My answer was simple: "Nobody can stop the progress of science, and television used for education is perhaps one of its best contributions to the progress of all mankind". The interview was published in the City late extra Edition of the *Daily News.*

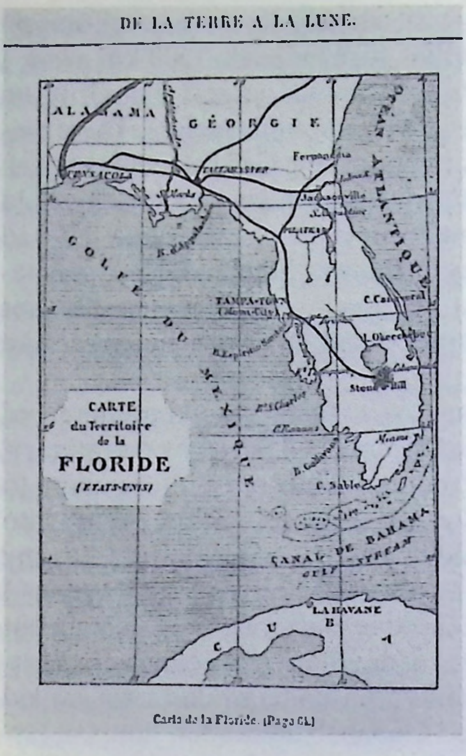
My main reason for flying to Durban had been to learn and report about South Africa's oceanography, but I did not expect the story I did in fact discover. I was introduced to Mrs Bela Davis, the director of the Natal Anti-shark Measures Bureau, who had succeeded to free 20 km of popular holiday beaches from the ever-present shark menace. Australia's defence, I knew, was to use steel nets, and in the USA chemical shark repellents are favoured. Mrs Davis used tough polyethylene ropes in which more than a 1000 sharks drown each year. As sharks get oxygen—rich water into their gills by forward swimming, she explained, but once they are stopped, they suffocate and drown. Every three days the nets are emptied of dead sharks, and every three months the nets are removed and repaired. Why the number of dead sharks had decreased from 1440 in 1966 to 1128 in 1968 was unknown to her. But if the trend continued, the answer seems obvious.

My last great adventure in South Africa was to visit a lonely desert research station and to reach it, first I had to fly west from Durban to Windhoek, 1600 km away. I stayed at the Grand Hotel in Windhoek, where I saw the largest meteorite on Earth, as it was claimed. (From memory it was about one cubic meter). There was also much in Windhoek to remind me of the once flourishing German colony which lasted from 1890 to 1919. The Kaiser and the Bismarck streets had still their old names, and I discovered a ruined building, proudly proclaiming that it once housed the 14.*Eisenbahner Kompanie.* (14th Company of Railway Soldiers). But I was really amazed when I ordered afternoon tea at my hotel and the coloured waiter asked me "Willst du auch Kuchen?" (Familiar German: "Wouldst thou like cake too?")

From Windhoek on, it was transport by Landrover, first to Swakopsmund and then to Walvis Bay on the coast of the Atlantic Ocean. I had been given a 'minder' (white of course), a nice young civil servant from the Ministry of Information, to whom the driving of a Landrover was a novel exercise. So, as we drove south into the Namib Desert, and the road was only a sand track along a thin line of trees, my driver often got stuck and could not master the four-wheel drive. I took over as I owned a Landrover in London and was experienced in mastering English mud, but found that I could drive just as well over sandy roads. There was no danger of getting lost, as the line of trees we followed marked an underground river, called Kuiseb. We reached the research station named Gobabeb after a few hours of fascinating driving for me.

A few native style round huts were the home and work stations of the director, Professor Dr Koch (absent) and Professor Eric Edney and their assistant. One hut served for visitors and there my minder and I spent the night. Professor Edney had devoted his life's study to insects, first at Birmingham University, then in Rhodesia and California, before coming to Gobabeb, where he concentrated on measuring the temperature difference inside white and black beetles. He devised a special thermometer of two microscopically thin wires to form a thermocouple. With it he found that the inside temperature, during the day-time sunshine was 70 °C. However, the temperature inside a white beetle was four degrees lower than in a black beetle.

On a table in one of the huts I found a large red book I knew well, a collection of space photographs taken by the American Gemini 5 spacecraft. I was greatly surprised to find it there, until I was told that some of these photographs were of the Namib Desert and served as maps for navigating the gigantic sand dunes of the region. On the photographs the dunes were just 6 mm in size, but proved the point that only pictures from space could reveal details which an aerial survey could never record in an overall picture.



Title 176

The original map of **Florida** as published on page 64 in Jules Verne's *De la Terre à la Lune* in 1865 which clearly shows Cape Canaveral, Lake Okeechobee and *La Columbiad* at Stone's Hill, the launch site of the Moon rocket. I had to use this map to find the imaginary Stone's Hill, but did not succeed. *Photographed from the Author's copy of the book.*

Title 184

Among the many writers of the fictitious flights to the Moon, **Jules Verne** has remained the most famous, being partly right and partly wrong in his forecasts. Born in Nantes 1828, he died in Amiens 1905, rich and famous in his lifetime. I had collected an almost complete set of his books in the *Edition polychrome*, which through the generous gift of J. Philip Gibbs Jr. went to the Bryn Mawr College Library. *Author's collection by an unknown silhouettist.*

After only a few weeks in London, I left again at the end of February 1969 for Cape Kennedy to report on the Apollo 9 dress rehearsal flight to the Moon. As usual there were the inevitable delays, this time due to a virus infection of the astronauts. I decided to explore a mystery which had intrigued me for many years.

As every school boy knows, in 1865 Jules Verne described in his famous book *From the Earth to the Moon* how three intrepid members of the Baltimore Gun Club flew to, and around the Moon, returned safely, and were picked up from the Ocean. He was correct in choosing Florida for the launch site, but very wrong to use a giant canon as the three astronauts would have been squashed to death between the exploding gases and the inertia of the air inside the canon. But where was Stone's Hill. (sic) in Florida, the launch site where the canon had been cast and buried deep down in the earth? I was determined to find it, I had a car and spare time.

Verne gave its latitude as 27° 7' north and 5° 7' west of the Washington meridian, as well as 79° 53' west of the meridian of Paris. But these two coordinates do not agree when translated to the Greenwich meridian, and thus I had to rely on Verne's original French book-map which clearly shows 'Stone's Hill', south of the great inland Lake Okeechobee which can be seen on all maps, ancient and modern. A short drive of about 200 km from the Cape brought me to its shores, to a small community, called Lake Harbour.

The southern half of Florida is as flat as Holland with unlimited vision to the horizon. I drove along kilometers of sugarcane fields, of grass lands with uncountable herds of cattle, but there was neither a hill nor a single stone, let alone a Stone's Hill to be seen anywhere. Lake Harbour is a sleepy farming village with a few old houses, a general store with its post office, all under a cloudless blue sky, the very antithesis of the present bustling spaceport for the Apollo launch.

I went into the store and asked the Post Mistress, 68 year old Miss Pope, if she had ever heard of a locality called Stone's Hill in the neighbourhood. "No Sir" she replied "and I have lived here since I was 6 years old." She had just heard of an old book about the Moon, but never read it.

So I left Lake Harbour sadly, but admiring Verne's imagination to invent a Stone's Hill in his Paris studio, trying to picture for himself more than 150 years ago the still unexplored centre of Florida. This lack of exact knowledge can also explain why his map on page 64 of the original first edition, of which I still have a copy in my collection, is so inaccurate. I never wrote this tale for my newspaper, it would have had no chance of publication

It was the trial experiment for a manned landing on the Moon and it was perfect, in the judgment of NASA. At the same time, it also served as a vital training for me to report as fully as possible about all the exciting details which occurred during the 10-day mission, still only in orbit around the Earth. But for me it was a rare event, as at the end I received a letter of congratulations from the Foreign Editor of the *Daily Telegraph*, the only one in 10 years of my employment with the newspaper.

My Apollo 9 note book contained 55 pages, half of it in single-space typing and the other half in closely hand-written notes. The pages were small, 20 × 14 cm. Every 6 months I had my notes bound in full leather as a small book, and they are now lying beside me while I am using my PC, a Macintosh Powerbook 3400c.

Apollo 9 was the crucial test for the whole concept of having two spacecraft for the lunar landing flight. One, the Lunar Module, the LM, the other the Command and Service Module, the CSM, both flying combined as a single unit to the Moon. There in lunar orbit, they separated for the LM to descend to the surface, the CSM remaining in lunar orbit. The LM had its own rocket propelled Ascent Stage which brought the two astronauts back into orbit, there to dock with the CSM which had during the lunar surface expedition stayed in orbit around the Moon and was occupied by only one astronaut, often called jokingly 'the taxi driver'. After docking, the two Moon explorers crawled back into the CSM, the ascent stage was discarded to crash-land on the Moon, and the CSM started its return to Earth and splashdown in the Atlantic Ocean.

It was a most imaginative and courageous concept which Apollo 9 tested in Earth orbit, as an essential trial of all the many mechanical, electronic and, last but not least, all the human actions which had to work perfectly before a landing on the Moon was to be attempted.

It was also a severe test for television from space and, although previously used, never before shown three astronauts in two spacecraft. One of them even went on a space-walk, inspecting from the outside the LM and the CSM, showing us on Earth what they really looked like. There was much talking between the three astronauts, and it could be heard and watched by millions all over the Earth. At last the Apollo project captured the imagination of old and young alike, as it had done for me years ago. I was exhilarated to be able to play a small part by communicating this great saga.

Apollo 9 — Lengths of published Reports Title 178

The importance of an English newspaper article is judged by its position and length, expressed in *column inches*. Although a poor measure, it does give an indication of the value of the contribution, as it is considered by the author and the various editors who have handled it through publication.

Because the whole of this book is metric, I have here introduced as a new measure: *column centimeters, C-C.*

DATE	*HEAD LINE 1969*	*C-C*
March 1	On the Apollo 9 Trail	27
	Apollo Captain expects something to fail	30
2	Busy training schedule	7
	Virus fells Apollo 9 astronauts	13
	Apollo flight postponement	7
March 3	Astronauts 'Fit'	4
	Apollo 9 Mission a step nearer to Moon Landing	44
4	Spacemen leave for lunar tests	7
	Delay in Apollo 9 docking	30
6	Astronauts's sickness stops space walk	21
7	Astronaut walks for 37 minutes in space	FP 36
8	US set for summer Moon trip	54
9	Moon landing is one test away	36
	Apollo rocket fault cured	7
10	Astronauts spend day on tests	17
11	Record sleep for Apollo crew	10
12	Apollo snag	4
13	Storm forces Apollo to move landing zone	10
14	Perfect end to Moon landing rehearsal	7
	Pinpoint Apollo Splashdown — 10 seconds late	35
17	Apollo 9 men film link-up	8

FP = Front Page

Mr Marsh, the Foreign Editor, sent me a telegram on March 10 addressed to me at Nassau Bay Motor Inn, Houston, Texas, from where I filed the latter half of my articles. He wrote:

> "Congratulations on some fine coverage throughout Apollo 9 shot — your efforts have paid off with an excellent show! Never quite as much as you like, I know — but still some good displays."

For Apollo 9 NASA, the National Air and Space Administration, issued 1403 press passes, as against 3497 for Apollo 11. A better measure of comparison than column centimeters, perhaps!

Although I spent April at my desk in London, I left again on 10 May for Prague to report the XII COSPAR International Space Science Conference. It was the only chance I ever had to interview Russian space scientists and engineers about their work, and I found their statements most interesting, although after Apollo 9 they frankly admitted that they had lost the 'Race to the Moon'. I sent articles to London every day, but apart from a few column centimeters nothing was published. I decided therefore to write a feature article "A new Age in Space Research" which summarised the then existing situation. It was 99 C-C long. (COSPAR = Committee on Space Research of ICSU = International Council of Scientific Unions, the World Federation of all Scientific Academies.)

One of the Russians with whom I talked said that the first American astronaut on the Moon would give the Russians a tremendous shock, and this might lead to greater Russian Government support for their own space endeavours. This in turn might even help NASA in their constant fight for greater financial help from Congress. The Russians were proud of their successful robot exploration of Mars and Venus.

At the Prague conference, an American space scientist compared the expenditure on the Vietnam War of £ 12500 million per year at 1969 value, with the Apollo cost of £ 1700 million, and estimated a manned flight to Mars at £ 40000 million, less than four times the Apollo budget. A great advantage of the Mars expedition, compared to the Vietnam War, was that all moneys would remain in America. Frank Borman, the captain of Apollo 8, when asked about his pay during the flight replied: "I received $ 450, the normal pay of a Colonel on active flying duty in the US Air Force." [The Apollo 8 flight lasted 147 hours]

As at this time a landing on the Moon appeared certain in the not too distant future, I wondered what would be the first words spoken by a man on landing. The *Sunday Telegraph* offered on 18 May a prize of £ 10, not a very great sum, for a quotation in English of less than 50 words, having accepted my suggestion to invite a public answer to the question. On 18 June it published the result. It was an extract from a speech by Winston Churchill: "This is not the end, it is not even the beginning of the end. But it is, perhaps, the end of the beginning". I found it a good quote, but much too long to remember for an excited astronaut on his historic achievement.

When Neil Armstrong stepped on lunar soil at the Sea of Tranquility on 20 July 1969, he exclaimed: "That's one small step for man, but a giant leap for mankind". There was great controversy for months afterwards, whether he said "a man" or "men".

After my visit to Prague to report on the International Space Science Conference in May, I was back in London for only a few weeks before 'Apollo 11 Fever' hit Fleet Street. These early stories before a great event, the preliminaries or "Prelims" for short, which I wrote were for example "Queen will send message to the Moon", an analysis "Why Russia had lost the Moon Race" and "Britain's contribution". All this was written in London, before I left on the standard flight to Florida. I might just mention here that Apollo 10, which had been reported by Alex Faulkner, the *Daily Telegraph's* New York Bureau Chief, flew faultlessly to within a few kilometers of the Moon's surface. In lunar orbit, it tested one more the complicated manoeuvres of undocking the LM from the CSM (see above) and again the docking on return. All went well and the launch date for Apollo 11 was set for 16 July 1969.

The owner of the *Daily Telegraph*, Lord Hartwell, decided wisely that on this most important story, I should be helped by his son, Adrian Berry, my assistant. We got on very well together, not only in the London Office, but also at the Cape and at Houston. When we had to share a room at the Cape, he only complained once, perhaps not unreasonably, when I smoked a cigar before breakfast. We both sent our stories to London through the New York Office, and it was left to the Sub-editors in Fleet Street whether in the next morning's paper, they appeared side by side, each having its own 'by-line' or if they were combined into one report with a joint by-line of both our names.

At Cape Canaveral the atmosphere was electric, highly charged with unending discussions among the 3500 representatives of the media, who had come from all over the world. The arrangements made by NASA for our work were almost perfect with press briefings several times a day to keep us informed of the latest state of affairs. The last Press Conference given by the three Astronauts which I had attended and reported had taken place in Washington on 5 July, when the three astronauts appeared behind a transparent plastic wall to shield them from the threat of any medical infection of the mass media. After their years of training, all three were very optimistic, as they had every right to be.

The documentation issued by NASA and the industrial contractors was voluminous, clearly and simply written for the non-scientific reporter. It was most generously distributed in an edition of 3500, so that everyone could have his or her own copy. Most important was the actual 'Flight Plan', setting out in perfect detail, minute by minute, each event, each action of each astronaut, so that we could easily and precisely follow the flight as it took place in space. Ours were exact copies of the Astronaut's own Flight Plans! One could not ask for more.

The issue of Flight Plans to the press was a further example of the Open Information Policy of the American Authorities which I have praised before. [See Titles 107 + 110]. One consequence was that we could synchronise our own times of eating, sleeping and working with those of the astronauts and thus avoid missing crucial events, like the first steps on the Moon's surface. It also allowed radio and television reporters, who had come from many different Time Zones on Earth, to inform their Home Offices of the most suitable times for broadcasting. Naturally preference in timing, where possible, was given by NASA to the United States, so that maximum publicity was achieved for those who had paid the estimated $ 22 billion for the whole of the Apollo Programme.

From the beginning of Apollo 1, I had saved and collected all official NASA documents of all flights, and later in London had them bound in hard cover cloth. For several of the later flights this amounted to more than one volume and at the end of the whole Apollo Saga, I had a long shelf of these precious historical records. Through my good friend, Frederick I. Ordway III, I donated them years later to the Space Museum in Huntsville, Alabama, where I trust they can today be consulted by interested scholars. It was at Huntsville that Wernher von Braun had designed and perfected the Saturn V Rocket, and where now a Museum for the Apollo Saga is established.

The Launch will always be unforgettable for me. Press buses collected us from our Motels in the middle of the night, and three hours before launch zero we were seated in the Press Stands, 5.6 km from where the Saturn V Rocket was standing, brilliantly lit in the predawn darkness. Loudspeaker comments came clearly and undistorted every few minutes, and I recorded them all in my notes, with exact times. "This is Mission Control at T minus 2 hours and counting. The hatch of the CSM is closed, the Earth atmosphere has been purged. The launch vehicle is Go." The comment of Arthur C. Clarke, at Mission Control, was also broadcast: "The last day of the old World."

It was a truly international crowd on the Press Stand. On my left was the American painter Robert McCall, drawing every 30 minutes a pen and wash sketch as night changed into dawn, and dawn into daylight. On my right was a Japanese television commentator, Jonji Kitadai from the Tokyo Broadcasting Company, and behind me sat Hans Höfner from the Deutsche Presse Agentur.

We were told the breakfast menu of the astronauts: Steak, scrambled eggs, orange juice and coffee. The pressures in all fuel cells were checked, and at "T—15 seconds" guidance was switched to internal, and vast pale yellow flames bellowed from below the rocket. "We have lift-off". One second later, the deafening roar hit my chest physically. I have never forgotten it.

Apollo 11 — My published Reports Title 182

I am here adopting the same lay-out as for Apollo 9, date, headline, length of the story in column-centimeters, C-C, FP = Front page, AB = with Adrian.

DATE	*HEADLINE 1969*	*C-C*
From London		
June 28	Scientists stand-by for Moon rocks	24
30	Laser Mirror on Moon may give Earthquake clues	22
July 2	Apollo Sleeping Pill Test	29
5	Three Paths to Manned Landing	21
5	Apollo Blast-off 12 Days away as Dream approaches Reality	FP 23
	Two Errors cost Russia Lead in Moon Race	1 pic + 38
6	British Ideas vital to US Moon shot	33
7	US Flag no 'territorial claim' on Moon	1 pic + 39
9	Space Monkey dies	20
10	Rocket Fuel Fire Test for Apollo	1 pic + 27
11	Helium Leak in Apollo repaired	FP 14
11	Two extra Revolutions before Apollo touches down	1 pic + 55
11	Moon Men use Old Principle	19
12	Moon Men 'In good Shape'	17
From Cape Kennedy		
14	Dangers they face	24
15	Milestones to Moon Conquest	4 pics + 28
15	Research Base Plan for Moon	1 cartoon + 15
15	Luna 15 Station Theory (Russian)	6
16	Housekeeping will be Astronauts first Moon Chore	86
16	Russia puts up Robot Moon Ship but America discounts Risk to Apollo	FP 83
16	Editorial 'Out of this World'	9
16	After ten Years Man finally makes his greatest Journey into Space	cartoon
16	Moon Landing depends on Module's fragile Legs and Ladder	85
17	Good Omen as Spacecraft thrusts towards the Moon + America's 7 Years from Earth Orbit to Apollo 11	52
17	Apollo set to put Man on the Moon + US to check on Luna 15 flight	FP 67
17	"Looking Good" for US Moon Trip + Apollo three-quarters second late	FP 7

Apollo 11 – My published Reports (Continued) Title 182 A

DATE	HEADLINE 1969	C-C
18	Luna set to land on Moon. Russian Medals on Apollo	FP 48
18	Astronauts taciturn	AB 1 pic + 53
19	Russian Assurance *'ALL CLEAR'* to Apollo	AB 68
20	No Rescue Hope	AB 26
20	Apollo 11 in Moon Orbit. "Like Perfect" says Armstrong	FP 128
From Manned Spacecraft Center, Houston		
21	Americans first on the Moon. + Eagle touches down in Football Pitch + Lunarnauts land safely	FP AB 157
22	FEATURE: Apollo 11 – Ultimate in Team Work	92
22	Moonwalk Mission costs US £ 148 million	28
22	Moonwalk Time Table	16
22	Water Clue in Care	30
22	'9, 8, 7 ... Proceed ... Beautiful!' + Space Link by Moon Men + Eagle blasts off for Space Rendezvous	1 pic + 158
23	Nine more Landings to explore the Moon	51
23	Moon Men speed Home into Pull of Earth	FP AB 42

DATE	*HEADLINE 1969*	*C-C*
July		
24	Moonquakes traced on Seismograph	FP 72
24	Space Observatory and Workshop planned for 1972 + 'Car Bump' Mishap in Docking	60
25	Moon Men safe back + Upside-down Splash to Scrubdown	FP AB 68
From Ellington Air Force Base, Houston		
26	Scare in Moon Plane	FP 20
26	Editorial 'Mission Accomplished'	24
27	Quarantined Moon Men peer from their Window at Cake Cutting	2 pics + 8
27	Apollo Moon Rock Box opened	FP 48
August 8	Experts divided on Carbon 'Find' in Moon Rocks	FP 28
11	Astronauts go to rejoin their Families	FP 37
11	Astronauts freed from Quarantine	34
13	Moonwalk easy says Armstrong "We were like boys in Candy store"	FP 73
14	2 M cheer Lunarnauts as US Tour begins	FP 51
From New York		
14	Health Concerns 'Natural Protection lost'	6
19	Aldrin took Communion on Moon	10
19	Lunarnauts Trip to London	4
26	Russian Manned Moon Shot expected soon	32
29	US Exploration of Space hinges on Atomic Engines	93

My reports on Apollo 11 total 23 column meters and 62 column centimeters.

Now I must also convey the conditions and the atmosphere at Mission Control Center, Houston, from which the major part of my reports originated. After reporting the launch from Cape Kennedy, I hurriedly drove to Melbourne, Florida, about 120 km away, to fly to Houston. The Mission Control Center was about 50 km from Houston Airport in a suburb, Nassau Bay.

A car was essential to reach the Center from my motel, and on entering it one was greeted by a complete Saturn V rocket with its CSM and LM attached, lying horizontally next to the road. It gave one the correct impression of size of what had to be launched from Earth for three astronauts to reach the Moon.

The whole Center consisted of numerous buildings, had its own power station and Mission Control itself was housed in a separate 10 story structure.

For the media, NASA had vacated a large hangar in which 500 seats had been prepared, each with its own television receiver and telephone. I could see the astronauts in their capsules, and later walking on the Moon. I had only to watch the screen, type my reports, and by direct telephone line dictate to the copy-taker in London's Fleet Street. Later when the Astronauts stepped on the Moon, events became exciting and time precious, as it was 3 o'clock in the morning in London. I did no longer type, but dictated directly what I saw on the screen. It was a strange symphony, 500 typewriters typing together, quicker or slow, loud or soft, according to events on the Moon. Unforgettable!

Title 184

Science fiction films are as popular as science fiction books, particularly if they deal with space travel to the Moon. Georges Méliès, the French film pioneer since 1896 and the first ever to film any fiction, had by 1902 made the first film of this genre, *Le Voyage dans la Lune* using Jules Verne's canon propulsion. By 1928 Fritz Lang's film *Frau im Mond* used rocket propulsion thanks to theoretical work by Oberth and others. *Poster design by Alfred Herrmann, courtesy foundation Deutsche Kinemathek.*

Title 184

Producing a giant **Vertical Canon** to fire a manned projectile to the Moon must have exercised the mind of Jules Verne for some time, or it was perhaps the engraver who found the answer. A very large circle of 30 independent foundries had to be established as well as the underground mould and central mandril, before at a given signal the molten metal would be allowed to flow down the slope simultaneously from all sides. *Engraving signed: Pannemaker – Doms fe. Author's Collection.*

Although, while in the USA, I did not have much spare time while writing my reports and looking after the inevitable household chores, like car hire, motel bookings, clean laundry and so on, my thoughts returned often to the predictions of the many writers who had forecast how man would reach the Moon and what he would find and do there. I had collected many of their books, read and remembered much.

These tales kept the dream alive through the centuries until I was privileged to see the Apollo's crew reaching the Moon. Some of the NASA scientists and engineers told me that they themselves had been inspired in their youth, particularly by Jules Verne's (1823-1905) *De la Terre a la Lune* 1865, and by H.G. Wells' *The first Man in the Moon* 1901. Wells used the fictitious anti-gravity substance 'Carvorite' for his flight and found intelligent ants on the Moon. Verne was wrong to use a cannon [see Title 176] but was wise to choose Florida for the launch, the ocean for return, the Moon uninhabited.

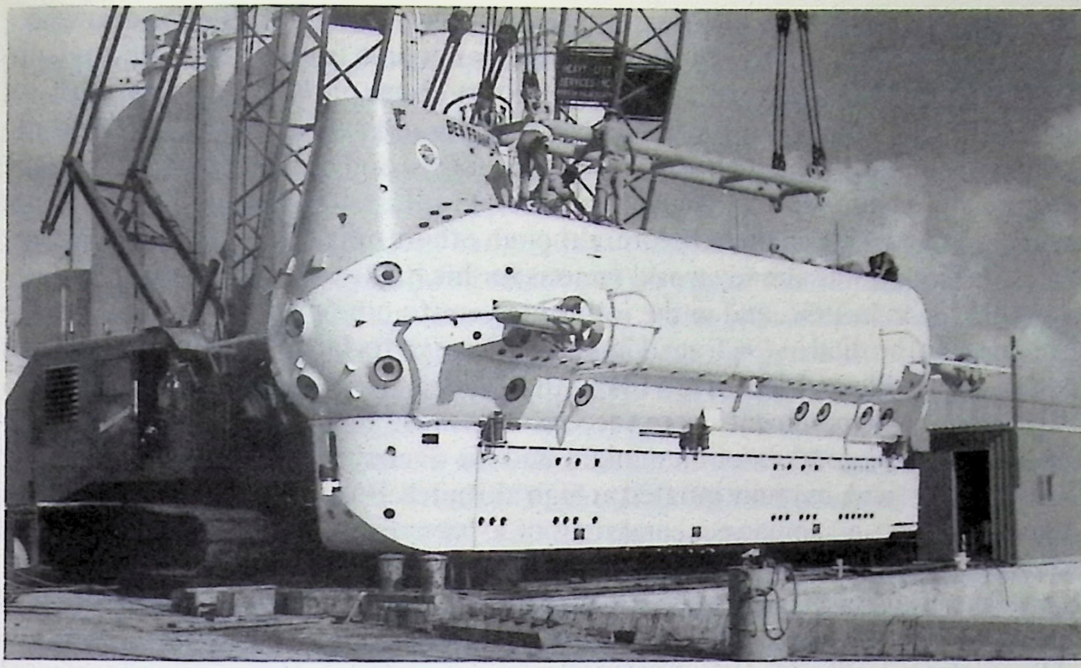
Historically the first to speculate, was Lucian of Samosata (about 125-190 AD) and the earliest translation into English I could buy was his *True Histories*, a book printed in Oxford in 1664. He described how travellers in a great sailing ship were caught in a 'whirlewind' and after seven days came to the Moon. There they fought, with the Men of the Moon against the Men of the Sun. Lucian warned his readers not to believe all the tales of his travellers.

John Wilkins (1614-1672) stated in his *The Discovery of a new World* 1638, that "tis probable there may be another Habitable World in the Moon". As Wilkins was the Lord Bishop of Chester, his book gained a wide readership.

In the 18th century there were many maps of the Moon based on observations and an anonymous book, in which the unknown author described travelling at 1000 miles an hour for 8½ months (6120000 miles!) and on reaching the 'nearest luminary' is greeted with noisy shouts by the Men of the Moon.

I found M.H. Nicholson's book *Voyages to the Moon* (MacMillan, New York 1948) the best survey of most of these imaginary voyages, although she left out the Baron Münchhausen's voyage—which is in fact an exact plagiarism of Lucian's, but the Baron fights alone for the Moon Men.

In this brief summary, Arthur C. Clarke must not be forgotten, although his imaginary tales are based on science and on the far future. May they be more accurate predictions than those of previous authors, none of whom, except Jules Verne in some details, got anywhere near the true facts. These books were inspiring and they served to remind us of our destiny, they kept the dream alive until science and technology were ready to make it come true.



Title 185

The intermediate-depth submarine, the Mesoscaphe *Ben Franklin* in which Jacques Piccard drifted submerged in the Gulf stream from 14 July to 14 August 1969, covering 2800 km. It was constructed by Grumman Aerospace in 1968 following the design of J. Piccard who was accompanied by five scientists, one Swiss, three American and one English. *Courtesy Jacques Piccard.*

I first met Professor Auguste Piccard in the summer of 1936 in Santander, where the University of Madrid had organised a summer course for non-Spanish students. We were housed in an old royal castle on the rocky shore of the North Spanish coast with a delightful private bay for our daily swim. There I saw a very tall professor in a minute swimming trunk with astonishing spectacles, one of his unsung inventions. They are now commonplace, small attachable sun filters, to be turned up when not needed. I had never seen these before, although others may have used them earlier. Professor Piccard was already world famous for his balloon ascents into the stratosphere, 15781 m in 1931, and in the following year to a height of 16940 m. I never saw him again, he died in 1962, aged 78 years. Many years later in Switzerland, I met his son Jacques Piccard. [See Title 104]

The record balloon ascents were successful because Piccard had constructed an air-tight spherical gondola of aluminium and an over-sized balloon, only slightly filled on the ground, but fully inflated at high altitudes. Based on the same principle, he invented later a submarine, consisting of a pressure resistant steel sphere, attached to a lighter-than-water gasoline filled 'buoyant balloon'. This allowed him, with heavy weights magnetically attached to his gondola, to descend to record depths of water. He called it a 'bathyscaphe' and named it *The Trieste.*

His son Jacques, like his father a physicist-engineer, helped him in the design and construction of the bathyscaphe, and together they descended in *The Trieste* to a depth of 3099 m near the Island of Ponza in Italy. By 1964 Jacques had constructed a standard type submarine for tourists, the mesoscaphe and I had a voyage in her in the Lake of Geneva. Jacques Piccard had also become world famous by then, as in his bathyscaphe *Trieste* (by then sold to the US Navy) she had under his command, reached the unbeatable record depth of 10916 m in the Mariana Trench in the Pacific Ocean.

Undismayed by his failure of the tourist submarine, Jacques conceived the idea of drifting submerged in the Gulf Stream with a new submarine also a 'mesoscaphe' (intermediate depth), named *Ben Franklin.* It was soon called the 'Underwater Kon-Tiki'. His drift started in West Palm Beach, Florida, and ended near Halifax, Nova Scotia, a distance of 1444 nautical miles, after 31 days, at an average speed of 2 miles per hour. A great scientific success!

But as it coincided with the Apollo 11 flight, it never received any publicity and was but sparsely acknowledged. As I was in Florida at the time and knew about it, I went to see Jacques and talked to him fully. My report, 64 column-centimeters, appeared only on 8 September 1969 in the *Daily Telegraph* but was welcomed by Jacques when he saw it.

British Association and Peter Medawar Title 186

After the end of the Apollo 11 Saga, I did not immediately return to London, but stayed on in the USA for several weeks. From Houston I flew to Los Angeles, and by car drove to Pasadena, the home of NASA's Jet Propulsion Laboratory, the famous JPL, which was responsible for American unmanned spacecraft. I arrived there on 27 July 1969 and was lucky, because during that week the two unmanned Mariner 6 and Mariner 7 spacecraft reached Mars.

I sent full reports to London, and the first pictures in the *Daily Telegraph* were published on 31 July. They showed relative close-ups of the Martian polar ice caps from a distance of 916000 km from its surface. I also went to Jack Ass Flats in the Mojave Desert [see Title 102] to learn about atomic propulsion for spacecraft, probably the one and only place on Earth where this far-future research project had been successfully investigated.

Back to London, and I have a note that on my birthday, 22 August, I gave a lecture on 'Communication of Science' to the H.G. Wells Society of which I was a member. On 1 September I was in Exeter, in the Southwest of England, to take part in the British Association Meeting at the University there. I have already given [See Titles 152-154] a general description of the AAAS, and the only difference between this and the British Association is the latter's more strict organisation into the various disciplines.

During the Exeter Meeting of the British Association, Sir Peter Medawar OM FRS was the President. He was the most distinguished British scientist at the time, Order of Merit, Nobel Laureate, Companion of Honour and Fellow of the Royal Society. He was sure to be chosen as the next President of the Royal Society, if he had not become seriously ill before he could be elected. As was customary, on the Sunday, always in the middle of the BA Meeting, a special Church Service was held at the local Cathedral, and it was there that the President, Sir Peter, was to read the lesson from the pulpit.

It was the saddest event I ever had to report. Sir Peter, a member of the ISR Editorial Board, whom I knew well, started to read, but soon he slowed down and his voice became quite indistinct and blurred. One could see that he was in great pain, and then he collapsed in the pulpit. There being no stretcher, he was placed in a wheelchair, moved to an ambulance and transferred to the local Royal Devon and Exeter Hospital. No true statement of his condition was at first released, and only after weeks it became known that he suffered from partial paralysis. In spite of this, he continued to write articles and books, which he dictated to his devoted wife. He died in 1987, and in December of that year a Memorial Service was held which I attended. [See Title 186A]

WESTMINSTER ABBEY

SERVICE OF THANKSGIVING

for the Life and Work of

SIR PETER MEDAWAR

O.M., C.H., C.B.E., F.R.S.,

1915 — 1987

Let us give thanks for Peter Medawar's great achievements and pray for those who today continue the work he began.

O GOD, whose kingdom has set within our hearts the quest for knowledge and dominion in the natural world, teach us to use all science, invention and technology
not to hurt but to heal,
not to destroy but to build,
not to divide but to unite thy human family in
prosperity and dignity together.
And let not our knowledge outstrip our wisdom;
through Jesus Christ our Lord. *Amen.*

Monday, 7 December, 1987

12 Noon

Title 186A

Service of thanksgiving for Sir Peter Medawar.

While I was editing *Discovery,* and ever since the International Geophysical Year of 1957-1959, I published a regular column about the IGY every month, in which the Antarctic featured regularly [see Title 63]. I became deeply interested and started to collect the classical books of the heroic period of Antarctic exploration, the works of Scott, Amundsen, Charcot, Cherry-Garrard, Franklin, Hurley, Nansen, Peary, Ross, Shackleton and Weddel. [See Title 51] It had become a large and valuable collection of which I was proud, but I had to sell it at Christie's in April 1988. It was hard to part with it.

After I joined the staff of the *Daily Telegraph* in 1963 as their Science Correspondent, I was able to consider the possibility of travelling to the Antarctic myself, and I planned and schemed to obtain an invitation, without which a visit would have been impossible. Sir Vivian Fuchs, Director of the British Antarctic Survey in Cambridge, was kind enough to invite me to visit Halley Bay, the main British Station and to report from there. But travelling was lengthy, by plane to Valparaiso, and then by sea for two weeks to get to Halley Bay and two weeks to get back. I discussed the invitation with my Editor but he turned it down, saying: "We couldn't afford to have you on a sea cruise for a month without filing any copy". I had to agree with his reasonable reply.

I then went to see Dr Gordon de Q. Robin, director of the Scott Polar Research Institute, also in Cambridge, and he told me of his joint work with Dr S. Evans of his Institute, to measure the Antarctic ice thickness by radar from an aircraft which was to be tried out by the US Navy. "Why don't you come with us and report on this unique Anglo-American project for a British Newspaper?" It was a brilliant idea and I went to work on it immediately. On my next visit to Washington, I saw the National Science Foundation which supports most American basic research, including Antarctic science. I asked them for permission to report on the radar research in the Antarctic.

They approved of my visit, but added a proviso that I also obtained clearance from the US Navy which at that time, 1989, provided all the essential infrastructure, transport, sustenance, heating and housing, as well as the essential polar clothing. Through the Naval Attaché at the British Embassy in Washington, I obtained an introduction to the American Admiral in charge of the Antarctic Sector. He also approved, but added the further proviso that I had to obtain a medical certificate of my perfect mental and physical health. Considering the not unlikely emergencies in the Antarctic, I appreciated the essential need for an assurance of normal behaviour when the survival of an isolated group depended on it. I do not know what my doctor thought when I asked for a mental certificate, but he gave it and the Editor also gave his final seal of approval. Financing my visit was nowhere discussed.

The invitation to visit the Antarctic by the American Authorities was a most generous one. The *Daily Telegraph* had to pay my air fare from London to Washington DC and the return flight from the American continent back to London. All other expenses of the visit, the flight from Washington to Christchurch in New Zealand 35 200 km, where the main US 'shore base' was located, as well as all other flights to, and on, the Antarctic Continent were on MAC planes and free of charge. In addition there was, for more than three weeks, abundantly provided food on a 24 hour basis (but no alcoholic drinks, as the US Navy is dry), housing and heating, as well as the loan of ample polar clothing. This was all free to my Newspaper and to me.

I was pleased when six months after my visit and return to London I received a letter from Dr Simon Bourgin, the Science and Space Advisor to the United States Information Agency. He wrote: "I can recall very few reports from the Antarctic in the seven years I have been involved, that are so complete and put together so well. Will you accept my tardy congratulations on your Antarctic pieces of last year?" But see Title 200!

I left London on 22 October 1969 for Washington and again left on the 25th at 02.40 hours from Andrews Air Force Base, just outside the Nation's Capital, to fly on a westerly course by way of Travis, California, to Hickam Air Force Base, Honolulu. Our plane took off in a southerly direction at 02.30 hours on the 27th for Christchurch, New Zealand, where we arrived at 14.10, all times being local. I lost a day, 26 October, by passing the International Date Line.

This was not a commercial flight with such luxuries as any airline may consider obligatory to provide. I was the guest of MAC—the Military Air Command, the branch of the US Air Force responsible for strategic global air transportation services. I flew in a C-141 *Starlifter*, a very large four-engined jet plane with an immense, but secret range of action. The inside of the plane is nothing but an empty shell, into which either a large number of seats can be fitted, or a number of armoured personnel carriers can roll, or a single large tank or helicopter can be manoeuvred, or for VIP Senators a mobile lounge, complete with bar (the US Air Force is not dry) and a stewardess can be accommodated.

In my case there were only seats for the scientists and technicians who were flying to the Antarctic for their summer work schedule. On my return flight there was a mixed cargo of a helicopter for repair in the USA, and a few seats. On both occasions the standard food was a box with a meal every four hours, night or day, consisting of large sandwiches and coffee. I had never before realised what global air superiority implied, and I was greatly impressed.

During World War II, I worked in a chemical laboratory during the day [see Title 30] and during the night I was active, often very active, as a part-time fireman during the *Blitz* in the western parts of London. [See Title 28] My fire station was 34-A-2X in Chelsea. My natural curiosity often drove me to re-visit in day-time the scenes of fires fought the night before, and soon I took a sketch pad with me to record the weird shapes of twisted girders and the avalanches of brick rubble which had blocked the streets.

The most colourful sights were the patterns of walls and interiors of rooms, revealed and laid bare by the complete collapse of the remainder of the building. There were bath tubs still attached to the blue wall-tiles of a bath room on the third floor, or the mirrors of a pink boudoir, incongruously juxtaposed on the floor below. These I sketched and watercoloured afterwards. Free nights I spent at life classes in the Art School of St Martin which helped me greatly to get my perspectives correct.

All this ended in 1945 when 'peace broke out' and other activities, like cinematography and temporary emigration to Australia [see Title 47 *et seq.*] fully occupied my time. I gave all these war-time sketches to Ann Aikman, my wife, as a wedding present and I do not know if they still exist, as she continued to live in Australia when I returned to England in 1954.

Not until 1969, 24 years later, when I, as the Science Correspondent of the *The Daily Telegraph*, was invited by the US Navy to visit Antarctica and the South Pole, that I took up sketching again and have continued it ever since. I record for my own pleasure such scenes of scientific or other scenic interest as I have been fortunate enough to visit during my travels all over the world.

My watercolour technique has remained the same, ever since I started in London during the war days. I make rapid outline sketches in Indian ink, using a Rotring Rapidograph or Rapidoliner, 0.35 mm. But as soon as possible, I colour them from memory. For that I have a paint-box with 24 half-cakes, which takes up very little space and can easily be packed. I have never coloured my sketches on the spot, and this has greatly helped me to develop my memory for colours. I have always used 140 lb, 300 gram per square meter, Bockingford acid-free paper, 10 × 7 inches, 254 × 178 mm.

Only a few of the 1200 watercolours I have by now accumulated can be of any direct scientific interest, but as each is accurately dated, they may be of some historical value in years to come. Apparently they have given some pleasure to those who have spent a few minutes looking at them.

Among my collection of Antarctic books I found frequent mention of Dr E.A. Wilson, a member of Captain Scott's second, fateful expedition to reach the South Pole, 1910-1913. Wilson died with Scott, Oates and Evans on their return journey. Dr Wilson, the medical chief of Scott's expedition was not only a painstaking biological observer, but also a superb watercolour artist, whose sketches are now permanently preserved at the Scott Polar Research Institute in Cambridge. They have been universally admired for their scientific accuracy and their delicate colouring.

They inspired me to try and follow his example, although I knew I would never reach his perfection. His technique was similar to mine, rapid outline of the sketches, by Wilson in pencil, followed by colouring on return to the expedition's heated hut. I never had any difficulties with my Rotring pen, even at the lowest Antarctic temperature I encountered of—40° (C or F). I could also retire for colouring to my warm 'Press Hut' at McMurdo.

Knowing in September 1969 that there might be a chance to visit the Antarctic, I bought a new box of watercolours and practised during holidays after more than 20 years lapse. I brought back from my Antarctic visit 25 watercolours, showing the US Air Force bases on which we landed, the aircraft on the ice, their inside during radar flights, the McMurdo base and its atomic power station, the South Pole, the volcanic Mt Erebus, Byrd Station and Shackleton's hut at Cape Royds on McMurdo Sound, as well as a number of other subjects.

Of Shackleton's Hut, built in 1908, I made a black-and-white sketch. In 1969 the Hut was still in perfect condition, lovingly maintained by New Zealand history-enthusiasts during their spare time from their nearby Scott Base. When Sir Ernest Shackleton's son, Lord Shackleton, was elected President of the Royal Geographical Society in June 1971, I thought my little sketch might find a place in the *Daily Telegraph,* whose Science Correspondent I then was. It was accepted and published on 4 June 1971, 15 column-centimeters long. I was offered the sum of £ 5 for it—the only time I have ever been paid for my artistic endeavours. This I considered an insult, either nothing as a member of staff, or a proper fee as an artist, working under most unusual circumstances.

'Watercolours for Science' became of sufficient interest to me to research its history, and I traced it back to Dürer (1471-1528) using it for some animal studies. Botanical illustrations in herbals also date back centuries. However, it was the many watercolours "Faithfully executed upon the spot from Nature" by Sydney Parkinson, watercolour artist on Captain Cook's *Endeavour* during the 18th century, which gave them the first real scientific approbation. In my opinion, he was the true originator of scientific watercolours. My article on this subject was published in *Leonardo* Vol. 14, No. 4, (1982).

A sad disappointment awaited me on landing in Christchurch. I was informed at the American Base Headquarters that the *Hercules* aircraft specially equipped for the Radar Ice Survey had not yet left the Lockheed factory in Marietta, Georgia, USA, where it was being modified.The special antenna for the radar had dropped off the plane twice during trial flights—a blessing in disguise for me and my Newspaper.

I immediately telegraphed my Foreign Editor, informing him of what I had been told—a delay of about 10 days, and I suggested to him that I would spend my time on reporting New Zealand science. This was approved, there being little alternative available! For me, the delay during the redesign of the antenna gave me a lucky chance to do what I liked best, talking to scientific friends and write about their work. I was also able to make a few sketches, while travelling through their beautiful country.

My first report from Christchurch was about the presence of four women scientists who were to go to the Antarctic ice, a few days after I met them. It was an unheard-of event that women should be in the Antarctic, it had never happened before in the century-old history of exploration on the ice continent. There was still much prejudice against them, and Dr Lois Jones told me that it had taken her four years before she obtained permission from the US Navy to carry out her research program in the ice-free areas of Victoria Land. My published story was 18 column-centimeters.

My second story from Christchurch dealt with the big Weather Watch planned for 1976 in which the famous GHOST balloons (Global Horizontal Sounding Technique) were to play a prominent role. Designed to float permanently in the jet-stream between 6 km and 16 km height around our planet, they would radio back either directly to Earth or to satellites, information about wind speed, humidity and temperature. By November 1969 the record flight of a Ghost balloon was 1 year and 2.5 months, circling the Earth 35 times.

About the discovery of a new deep ocean current I learnt from the American Oceanographic Research ship *Eltanin* which had then just docked at Lyttleton, NZ, on its return from surveying and measuring the new current. Dr Bruce Warren, the chief scientist aboard, explained to me the great economic importance of this new current as it would increase our knowledge of krill, the shrimp-like minute ocean creatures, the principal food for many whales. Krill exist in millions in huge swarms, thus feeding the whales. The krill itself depends for its food on the microscopic plankton, which in turn gets its nutrituion from the salts brought up by the deep ocean currents.

Before leaving Christchurch I must describe its two remarkable statues to Antarctic explorers, Scott and Byrd. Scott's life-size bronze figure stands in a small park on a high plinth. He is dressed in the full antarctic protective clothing of his period, and on his head there always sits a seagull, whose excretae have given Scott a white halo. The statue was sculpted by his wife, Lady Scott, and it is another bronze cast of the one in the centre of London in Waterloo Place, near the top of the Duke of York steps and the Royal Society.

Byrd's memorial in Christchurch can only be described as a three-dimensional triangle pointing south. Made of concrete, it is adorned with small stones from the Antarctic and on its north side, it has a recess, in which there is a bronze head of Byrd, with dedication: "The Great White Continent of Peace." Scott died in 1913, Byrd in 1957.

From Christchurch in the South Island I flew to Wellington in the North Island, the centre of New Zealand Science. I had a good friend there, Sir Charles Fleming FRS, then the President of the Royal Society of New Zealand, who later joined the Editorial Board of *Interdisciplinary Science Reviews.* I discussed with him the most important aspects of local science, which I was to review and which might be of sufficient news value for Fleet Street publication, always an essential aspect to bear in mind.

We agreed on the following subjects, here only given in the headlines under which they were published. "Pine Forest Harvest in New Zealand" (29 Column Centimeter, CC); "Search for Sulphur in New Zealand" (14 CC). This report originated as a by-product from my visit to Wairaki, the famous geothermal station where the superheated steam from the ground drives a turbine coupled to an electricity generator. It was called "Underground Steam" (31 CC) and was a detailed account of NZ geophysical research.

As New Zealand is prone to earthquakes, much research has been devoted to safer buildings, to recording earthquakes fully and to explore the depths below the surface of the Earth. A new shock recorder had been developed to be placed in tall buildings to measure their ability to withstand shocks and tremors. It proved so successful that it was mass-produced under licence in America, where its installation is now mandatory in California.

Another revolutionary research technique was described to me by Dr Trevor Hatherton, the Director of Geophysical Science of the Department of Scientific and Industrial Research. He borrows the electrical power lines from the national grid at 02.00 hours and sends a gigantic electrical pulse through them, which penetrates to a depth of 30 km into the Earth. In the regions of hot geysers and of geothermal power, where the nearness of the magma is greatest, he found new hot areas deep down. These were later confirmed by drilling and will in future yield new power for geothermal electricity.

I had by then spent 13 days in New Zealand reporting about its science, and had kept in constant telephonic touch with the Antarctic Base Headquarters in Christchurch. On 9 November 1969 I learnt that the special radar survey aircraft would still not be available for another 10 days, and as there was nothing further for me to report from New Zealand, I looked for other subjects abroad. I had heard that at Bluff in the South Island, where there was surplus hydro-electricity, bauxite was being smelted into aluminium metal. The bauxite (naturally occurring aluminium oxide) was mined on a very large scale from an open-cast bauxite mine at Weipa in the North of Australia by COMALCO, a company which had large British interests. I decided that this would be a good story, and I telegraphed my Foreign Editor; he agreed.

The mine is situated 15° degrees south of the Equator in the York Peninsula, North Queensland, and to reach it from Christchurch, New Zealand, I had to fly first to Auckland, then to Sydney, Brisbane, further north to Cairns and then on by private company plane to Weipa, a total distance of 4800 km. Weipa bauxite was discovered by a geologist of the Australian Conzinc Rio Tinto Company in 1955, and it has been estimated that the mine contains one quarter of all known reserves of bauxite for smelting aluminium. It is run by the Commonwealth Aluminium Company, COMALCO, in which the British Rio Tinto Zinc had at the time a 42% interest, the American Kaiser Aluminium 50%, and the remainder held by the Australian company.

The Weipa Mine was as immense in all respects as the Mount Tom Price iron ore mine on the north-west coast of Australia which I had seen [See Title 134]. A man working at Weipa received a weekly wage of £ 100 Australian pounds, a huge wage in those days. With a temperature of 32 °C at 08.00 hours, I was not surprised to be informed that the average consumption of beer per man per day was 1.87 Imperial gallons, a truly Gargantuan statistic. Mammoth shovels scrape up the bauxite ore and dump it into 100 ton trucks which move their load to a central tip. Then a conveyor belt transfers it directly to ships at a rate of 3300 tons per hour and the loading is completed during one tide.

But Weipa was also historically interesting, as in 1602, the first landings on the Australian Continent by a European, a Dutchman, took place there. Then in 1870 an Aboriginal Mission was founded, but had to be moved when bauxite mining started, and the Company had to build a modern equivalent housing estate for them. I saw it and found it better than the townships built by the South African Government for their Bantu natives, which I had also inspected. [See Title 171] My story, airmailed to Fleet Street, was never published, 10000 km travelled in vain! To me this was proof of the wealth of the *Daily Telegraph,* able to throw away a story, that must have cost £ 1000 at least to find, visit and report.

I thought my Weipa story had deserved publication. There was Macro-Engineering in the tropics, British commercial interests and a good housing estate for the Aborigines built by the Company to recommend it. But I finally concluded that the night copy taster, who decides 'print' or 'waste paper basket', did not read it carefully enough. I had flown 9600 km and spent about £ 1000 pounds sterling on air fares and motels, but expense is perhaps rightly irrelevant for a rich newspaper, such as the *Daily Telegraph.*

Returning to Christchurch, I stopped in Sydney, I saw my family and filed a story "Starfish destroys quarter of Barrier Reef" (20 CC), and from Canberra I sent a report on "Moon is frozen dust cloud says Rock Expert" (35 CC). The headlines were of course not written by me. The rock expert was Professor A.R. Ringwood of the Australian National University. I also visited Mount Stromlo Observatory, where the Anglo-Australian Telescope Project was being started.

I arrived back punctually on 20 November in Christchurch, and at once sent a short report about a fatal crash of an American Navy helicopter in which Mr J. Sykes, a British television director and an American scientist had been killed in the Antarctic. Engine failure was suspected.

But there was still a delay of at least another week before the Cambridge radar team and I could leave for the Antarctic Continent, and I had therefore to find another subject. I decided to fly to Auckland, the Headquarter of Air New Zealand, the National Airline, to investigate the chances of tourist excursions to the Antarctic. On 27 November 1969 I interviewed Mr Vernon J. Mitchell, the Manager of the airline's information services. He told me of the optimistic plans then being discussed of flying tourists to McMurdo, the American base on the Antarctic Continent. The tourists could eat and sleep on a special ship moved there during the summer, and would have 10 days for sightseeing, inspecting the research facilities and the nearby New Zealand Station. Fishing through holes in the ice was to be another entertainment. Linblad of New York had been engaged for this very expensive summer tour. It never took place, as I imagine the American Authorities refused it because of the inherent dangers of flying in the Antarctic. They were right!

It was exactly 10 years after the date of my interview, on 28 November 1979, that Flight 901 of Air New Zealand, on a routine tourist flight over the Antarctic crashed into Mount Erebus, killing all 237 passengers and crew on board the DC 10 plane. Lengthy investigation and legal controversies, up to the House of Lords followed, but no pilot error could be found. A wrong setting of the navigational computers was finally judged to be the cause. [See S. Steward *Air Disaster,* Arrow Books, 1986]

At last, on 1 December 1969, I left Christchurch for 'the ice', as the Antarctic Continent is colloquially called by all lucky enough to get there. I flew with many other scientists and technicians in a Hercules, a four engined turbo-prop aircraft of the US Navy Air Command. the 3680 km which took 10 hours and 30 minutes. We landed on Williams Field, a smooth ice surface. The Hercules was fitted with both wheels and skis for this journey. At our landing, a number of small brightly coloured orange buses, with wheels, awaited us and took us for a half hour ride to McMurdo itself.

I was by then wearing half of my bright orange coloured polar survival kit, issued at Christchurch from the large Navy Stores. The other half, including typewriter and other small personal belongings were stowed in a big kit-bag, the carrying of which later produced a hernia, operated on after my return to London.

McMurdo is a small town of huts, of larger laboratories and administration buildings, a Church 'Our Holy Lady on the Snow', a small atomic power station (later dismantled and returned to the USA, see Title 199) and a large flag of the Stars and Stripes. The temperature was around zero degrees centigrade, the average at Midsummer, as it then was. I was quartered in the 'Press Hut', largish, well heated with its own oil stove and very comfortable with four beds. Only one other bed was occupied by a colleague from an American Mid-Western newspaper. Spartan of course, but when inevitably compared in my mind with the quarters of previous explorers of the Antarctic, decades ago, the Press Hut was luxurious.

The date of my arrival, 1 December 1969, coincided with the 10th Anniversary of signing the Antarctic Treaty in Washington in 1959 and hence a special day for celebrations. I had filed in advance from Christchurch a lengthy feature article about the history of Antarctic exploration, the national rivalries of territorial claims and acquisitions, as well as the significance of the Treaty, declaring the Antarctic a 'Land of Science', forbidding all military activities there, and resting all territorial claims for 30 years.(It was renewed in 1989 for another 30 years up to 2119). In 1959 it was signed and ratified by 16 nations. My essay was published on 1 December in the *Daily Telegraph.*

The McMurdo Sound, a bay 184 km long and 74 km wide, lies west of Ross Island and east of Victoria Land. It was discovered in 1841 by Sir James Clark Ross and has since then served in the summer, when it is practically ice-free, as the main access route for most Antarctic explorers. It was used by Scott and Shackleton, whose hut still today forms a well-preserved historical relic of the heroic past. During the International Geophysical Year of 1957-1959, America established its main base at the McMurdo Sound, near the historic hut, and near New Zealand's main Station, Scott Base, just across a small hill from the American McMurdo Base. The two are joined by a good road, which in the summer is easily travelled by Jeep.The relatively mild climate makes these two bases suitable for year-round occupation, although of course, the number of scientists and technicians is far greater in the Summer.

I had hardly moved into the Press Hut at McMurdo, when I was offered the very rare chance of a flight to the South Pole. Weight and space on these flights is at a great premium, as all supplies must be flown to the Pole during the summer months. During the continuous darkness of the winter, no flying is possible. However, mine was a special flight for the benefit of Commander A.E. Church, the US Navy Chief of Staff for Civil Engineering and his assistants. He was in charge of the Design and the Building of a new American South Pole Station, an urgent task, as I was soon to see for myself. The then existing 1969 station had been constructed during the IGY, 30 years ago, and had sunk several meters below the surface of the ice, owing to the tons of new snow deposited each year on its roofs. The new station for 16 scientists to overwinter was to have a 50 m diameter dome and four towers.

In a turbo-prop Hercules we flew the distance of 1300 km in three hours. We followed the way over the Beardmore Glacier, the same route which Captain Scott had taken in 1910. As the weather was good and no white-out, the pilot descended to a low altitude, so that we could clearly see the enormous crevasses in the glacier. It was almost impossible to visualise how a few men, dragging heavy sledges uphill, could cross this miniature Himalayan range. Looking down vertically into the crevasses, the white of the ice surface changed into a deep blue below and finished with a black streak at the bottom. Yet, Scott, Dr Wilson and their intrepid companions overcame this ice barrier successfully, only to die on the return journey by another route.

The first sight of any human activity, as we neared the South Pole, was a number of huge black balloons lying flat on the ice surface. Made of neoprene rubber, I was told, they were the oil fuel reservoirs for the winter months, refilled during the summer from supply aircraft, like our flight. At the South Pole itself, there were only a number of radio masts visible above the surface. The pilot could have landed anywhere on this flat ice field, but he chose the right spot, near the entrance to the underground station. Here we stood on ice that was in 1969 more than 3 km thick above sea level, and at this height and at a summer temperature of minus 40 degrees, I could only gasp for breath. [-40° is the only point of the temperature scales where Celsius and Fahrenheit are equal.]

I soon recovered without oxygen (held available for elderly Senators on a visit) and entered down an eerie tunnel, a long flights of steps, with large icicles hanging down from the sagging roofs, although large iron girders had been placed everywhere for support. All the girders were buckled and bent, such was the weight and the pressure from the ice above and on both sides. It was immediately obvious that major civil engineering work was essential, or a new station had to be built, if work at 90° South was to continue.

One look from Commander Church (and myself) sufficed to show that the Station was in urgent need of rebuilding, if any further safe human occupation was to continue at that site. We went on to the main room, serving for meals and for relaxation, where I met a sight I would never have expected. Its walls were covered—at that time—with life-size naked pin-up girls, some with specially lit up breasts from light bulbs hidden behind them. But then, to spend 6 months below the ice during the winter service, when on the surface there is perpetual night, one can understand anything, even these super-pornographic pictures.

I took ample notes during my visit on 2 December 1969 and my report was published two days later in the *Daily Telegraph.* It was headlined "South Pole shifts half-a-mile since 1957" and carried the by-line 'Dr Anthony Michaelis at the American Amundsen-Scott South Pole Station'. This was the correct formal name given in honour of the first two explorers to reach 90° South. It was the furthest point I could ever hope to reach on Planet Earth—I never got to the North Pole, although fairly near in the Canadian North. [See Title 252]

The main research that was going on at the South Pole Station was, at that time, concerned with earthquakes, of which this site is absolutely free, and with the ionosphere. (The now gradually increasing ozone hole was not discovered until the mid-1980s). The propagation of electromagnetic waves, including radio, as well as the parameters of the atmosphere, were all constantly and automatically measured and recorded. I was told that future research would include the study of human behaviour in isolation, in view of space flights to Mars, and the adaptation of humans to high altitudes, living at the 3 km height of the South Pole Station. [See also Title 51 for similar Australian research]

After an excellent lunch, we went back up to the surface again, where a tractor-drawn sledge took us to both the old and the new South Pole. The old one was marked with a simple wooden pole, whereas the new one had a ring of the 15 flags of the signatories of the Antarctic Treaty, flying in an eight-knot wind. In the centre of the ring stood a large pole with the Star and Stripes, the 16th signatory, with a wreath of red flowers at its foot, commemorating the 40th anniversary of Admiral Byrd's flight over the South Pole.

It is now generally recognised that his flights into the Antarctic, and particularly this polar flight, mark the dividing line of polar activities, moving from the heroic to the technological exploration. But why the South Pole had moved, whether in a straight line or on a circular path, nobody could tell me.

The return flight to McMurdo was routine, remarkable as an achievement and as exciting as the whole day had been for me. As there was sufficient time at the Station, I was able to make a few sketches, and I wondered how Dr Wilson would have envied me for the comfort of it all.

Polar Do's and Don'ts is the title of a two-page leaflet [See next Title] issued by the Navy to every newcomer to the White Continent. It is obviously necessary to be specially clothed, when walking around the South Pole at -40°. Our clothing issue was generous, as all provisions of the Navy proved to be, especially with regard to food, available from a 24-hour luxurious buffet without having to pay. Alcoholic drinks were only obtainable for cash from a US Air Force bar, where a tumbler full of Cointreau liqueur cost 25 US cents.

Keeping the human body healthy, warm and ever prepared for possible emergencies was the primary duty of the US Navy, designated at my time to act in support of all scientific activities. The Navy took its duty extremely seriously, as any rescue operation was very costly, time—consuming and brought others into often more dangerous situations than those to be rescued. Flying by helicopter is considered particularly dangerous, and my first report from the Antarctic was about a helicopter crash there. The disaster of Air New Zealand in 1979, 10 years after my visit, when their plane crashed into Mount Erebus, 3000 m high, with the loss of all lives, was aggravated by the much—feared invisibility caused by 'whiteout', when sky and ground are undistinguishably white. I saw it a number of times during my visit.

The ruler over all American Antarctic activities, and by virtue of his command, the chief of all transportation and communication facilities, was at my time Rear Admiral D.F. (Kelly) Welch USN, the 'uncrowned king'. I would not call his kingdom an entirely happy one, as the dichotomy between his duty and the safe-keeping of all scientists and their often excessive demands—from his perspective—led to controversies. I was soon to experience his absolute power myself.

Admiral Welch gave all newcomers an interesting briefing shortly before our departure from Christchurch. Of the total permanent American population on the ice of 904, only 559 overwinter. All summer Americans in 1969 numbered 2158. During the previous summer 26000 tons of food and other supplies were shipped by sea, half of which was fuel oil. By air, supplies reached 720 tons delivered to Williams Field. Oil storage amounted to 6500000 gallons, sufficient for one year. He agreed that atomic power was cheaper than fuel oil for Diesel electric generation. Since 1957, when American operations began, the United States had invested \$ 25 million. With reference to the Russian Station, with which visits were exchanged, Admiral Welch remarked: "Here the environment is the enemy, and not ideology, and that is very refreshing".

He mentioned that sports were available for his men, such as broom hockey (?), volley ball, rugby games with the 'All White' team from the New Zealand Scott Base, and ice sailing. Financially, a total expenditure of \$ 35 to \$ 39 million was essential each year, and it cost the sum of \$ 150000 to keep one man in the Antarctic for one year. (I calculated that my three weeks on the ice cost the US Government \$ 8654, or \$ 412 a day, the equivalent of a five-star hotel). A cut in his annual budget of 25 %, Admiral Welch said, would mean the end of all American scientific activity on the White Continent.

Following the briefing by Admiral Welch, Commander E.G. Lightsey USN, the Officer in Command of Advanced Headquarters, gave us a stern talk on 'Survival in the Antarctic'. He started by describing our clothing issue of four pairs of trousers, two always to be worn on top of each other, two shirts also to be worn on top of each other, one coat and one anorak of brilliant orange colour, two fur lined caps, three pairs of gloves all to be worn on top of each other and one white pair of 'bunny' boots.

He went on to warn us that emergency landings were by no means unusual, especially by helicopter, and that then life depended on wearing full antarctic survival clothing. Normal procedure was the wearing of comfortable clothing inside the aircraft, but it was an absolute order, that the remainder of the issue be stored in the kit bag and that it must accompany each passenger on all flights. As far as I could see when flying, everyone obeyed these orders.

Commander Lightsey gave an interesting explanation of the gloves. The inner one was of wool, the middle one of leather and the outer of fur, the so-called bear glove, to 'wipe up a dripping nose'. The fur was natural animal fur, which does not freeze, whereas synthetic fur does, he said. I had developed my own standard of 'cold', when the drip from my nose froze in my moustache. The hood of the anorak was similarly lined with natural fur.

The 'bunny' boots consisted of one inner and one outer boot, both of white rubber with thick foam rubber between them, the combination forming one single unit. Thus all natural heat generated by the feet was preserved. He warned us that four or five breaths, without prior heating of air, at -50 °F or -45 °C, would lead to freezing of the lungs, and perspiring was to be avoided at all costs.

The excellent leaflet *Polar Do's and Don'ts* was certainly warning enough to be careful in any emergency. The margins contained drawings how to communicate with low flying rescue planes by signals stamped into the snow:

F = food needed; W = engineer required; K = showed direction in which to proceed and LL = all well. Other geometrical figures had many other meanings. On the other margin of the leaflet were semaphore signs to be made by either still or moving arms and, lying flat on the ground, meant that a doctor was urgently needed.

The text of the leaflet could not have been more explicit. "The Polar Regions are not tolerant of mistakes". "Dares are neither offered, nor taken. Necessary risks are bad enough". "Do not touch metal with bare hands. If your hand should inadvertently stick to cold metal, urinate on the metal to warm it. If you stick both hands, you better have a buddy along".

That the Navy practised what it preached was demonstrated to me one week after my arrival, when I watched a team of nine US Navy parachutists showing their skill by jumping from a Hercules flying at a height of 900 m near Williams Field. As the bright orange parachutes drifted down against the pale blue Antarctic sky, I had to shield my eyes against the blinding brilliance of the ice and the snow—covered Mount Erebus in the background. This is the only active volcano in the Antarctic, and a small white cloud at its summit hinted at the volcano's internal activity.

As the parachutists landed, Dr F. Fry, the 30-year old commander of the team sped forward in his tracked ambulance to pick them up. I had talked to him earlier and he explained to me that weekly practice jumps were normal during the then prevailing 'warm' season. In case of a crash of a Hercules plane, the procedure was to try and land another Hercules as nearby as possible. This was often practicable because the terrain was predominantly flat ice in the Antarctic. If not, a Helicopter would be loaded into the rescue Hercules, flown to suitable terrain as near as possible, and the rescue team would jump from the helicopter, if it could not land near the crash.

All members of the team were fully trained in first aid, ice survival and crevasse rescue. Dr Fry spoke to me about the most recent helicopter crash which I reported the day I arrived, when speed had become vital, as all survival clothing had been burned in the ensuing magnesium fire. As a result the survivors were doing well in McMurdo's own hospital and had not to be evacuated to Christchurch. My story about the practice jumps I had witnessed was headlined in my newspaper "US Paras prepare for Antarctic Rescue" and was 33 CC long on 10 December 1969. I also made a sketch.

In the hostile environment of the Antarctic, duplication is an essential safeguard. For this, and economic reasons, a small pressurised-water atomic reactor, using 93% enriched uranium, was installed at McMurdo in 1962. I went to see it and Lt. Commander Reynolds told me that it had, with 85% reliability, provided electric power and had also distilled seawater to provide fresh water, always in short supply even for personal hygiene.

Like everyone else, I was allowed one shower a week, consisting of wetting, turning off water, soaping and washing down. The cost of installing the reactor had proved very high, as all components had to be no larger than 2.4 × 2.4 × 9.15 m to fit into the cargo planes. Of its 10 Mwe output, only 2 Mw were used for electricity and 8 Mw worked the air-cooled condensers. It had been twice refuelled, at a cost of $ 1 million for each new core in 1964 and in 1967. Spent fuel had been cooled down in underground caves, before being shipped back to the USA. [See also Title 88]

The most sensational scientific discovery during my time in Antarctica was the finding of certain dynosaur fossils, similar to those found in other parts of the Earth's Southern Hemisphere. This proved beyond doubt the existence of the prehistoric Gondwana Land, 200 million years ago, and gave incontrovertible proof to the Drift Theory of the Continents, first proposed by Dr Alfred L. Wegner and published in 1912. Dr Larry Gould and Dr Grover Murray, two eminent American geologists, told me at the time in the Antarctic: "This is one of the truly great fossil finds of all times."

The original discovery had occurred on 23 November 1969 by Dr David Elliot of the Institute of Polar Studies of Ohio State University, while he was working in sandstone beds of Coalsack Bluff in the Central Trans-Antarctic Mountains. At that time, no news of this important find was released. On 4 December, part of a reptilian skull was discovered and identified by Dr E.H. Colbert as *Lystrosaurus* and this fact was released. I had written my report about the first find before anyone else on 4 December and handed it on that date to the American Communications Office for transmission to London, as was my usual practice. I was informed that my story had not been sent, no reason being given.

I therefore wrote it out again on an Official International Telegram Form and went with it to the New Zealand public Post Office at Scotts Base, a few kilometers from McMurdo. Again it was returned to me with the comment "Held by R.S. Willis" the Director of the Scott base. On its back was stamped: "4 December Scott Base Ross Dependency", as well as a friendly note: "Anthony, if this is to go at a later date, hang on to it for word check purposes Regards Derek." I cannot now recall who Derek was, but he was certainly my only friend at the time. I sent many Service Messages to Fleet Street about these events, to receive only the classic reply from the Chief News Editor: "Dynosaurs unsighted"!

These two refusals to transmit my story from the Antarctic on 4 December proved Official Censorship by the Public Information Office of the National Science Foundation in Washington. They had decided that such an important discovery had to be released by them, as indeed they did on 6 December, and not by me from the Antarctic on 4 December. They must have informed Admiral Welch of their decision, he blocked American communication channels, and in turn insisted that the New Zealand Post Office must do likewise. On 8 December the story appeared in the *Daily Telegraph* as "South Pole Hippo proves Continents were joined" with a New York date line. I received on 6 December the following telegram: "Fossil Story released here. Local Office Daily Telegraph informed. No embargo your filing. *Signed* Paine, Public Info Office, Nat Sci Foundation, Washington."

It was the only case of censorship in my 10 years as science correspondent, and it left me very bitter and disgusted. Was Dr Bourgin's letter of congratulation, see Title 188, a belated letter of apology?

When I realised that the National Science Foundation in Washington had exercised censorship of an important science story through Admiral Welch and had stopped its transmission to the *Daily Telegraph* in London, I had only two possible actions open to me: To demand an interview with the Admiral and insist on an immediate flight back to Christchurch, or alternatively refuse to report any further American science to London. I did the latter, and concentrated exclusively on the British Radar Ice Survey. I was of course furious then, and am no less so now, after more than 30 years, that bureaucracy could suppress scientific news of greatest importance.

I had followed for years the work of Robin and Evans at the Scott Polar Research Institute in Cambridge, and it was through this work that I had received an official American invitation to the Antarctic. However, there had been no test flights and therefore nothing to report. All the minor technical faults of the complicated electronic radar equipment had to be rectified before any flight testing could be started. Perhaps fortunately, a blizzard was then roaring over McMurdo, making all flights impossible. I had time to 'cool down' after the serious blow to my ego, and I found some solace in tumblers of Drambuie at the US Air Force bar.

Finally on 9 December, Hercules LC 320 took off for its first test flight of ten hours, covering a distance of 3600 km. Years of research, months of preparations, and days of delay through snow storms, finally led to this great flight. I was happy to be aboard as an observer. On the 19 December, after several more flights, I wrote my report for the *Daily Telegraph* which was transmitted without any difficulty to London. It was published on 29 December, headlined: "Science in the Antarctic—British Survey of the Ice". It was given only 18 column-centimeters. Indeed, the wheels of science writing rarely grind as poorly and as slowly as this.

What the published report did not contain was a description of the interior of the aircraft. Like the Starlifter aircraft, the Hercules is an empty shell which can be furnished with any necessary equipment, material or personnel. In our case it had been converted into an electronic laboratory with its own miniature television screens. On these Robin and Evans, as well as I, followed for hours the blue electronic graphs which spelled out the two echoes from the radar pulses broadcast vertically downwards from a height of 9 km. One graph reflected the echo from the surface of the ice, the other the echo from the underlying rock surface, the difference being the ice thickness. On this inaugural flight the ice thickness was found to be as much as 1372 meters. The results were considered excellent, and many similar flights followed in which I participated. The utilitarian structure of the LC 320 does not provide any windows or portholes, and the uniform white ice below never changed.

Return—AAAS Boston, Student Revolt Title 202

I felt sure I had accomplished my mission. From inside a darkened aircraft, I had watched for endless hours the radar echoes returning from the ice below. There was nothing to see when looking out, white, white ice. I determined to take the next available flight for Christchurch, New Zealand, on 18 December. From there, by MAC through Hickam Base to San Francisco had also become routine, with sandwiches and coffee every 4 hours, day and night.

I remember my great joy in Christchurch, strolling through its beautiful botanical gardens and seeing lush green plants everywhere, a great relief from the all-surrounding white of the weeks before. In San Francisco I became an ordinary civilian again, having to pay my own air fares, first to New York and then on to Boston from where I was to report on the 136th Meeting of the American Association for the Advancement of Science, the AAAS.

It was certainly a change to live again in the luxury of a Sheraton Hotel in Boston with my own bathroom which I could use at any time, instead of the weekly shower in the Antarctic and where there existed only the Navy's traditional 'heads' for defaecation. (The heads were long wooden benches with many holes in line, some always occupied).

The 1969 Meeting of the AAAS was very different from the one in New York in 1967 which I described before. [See Title 153] Again I arrived on Christmas Day, and at once filed my first story, welcoming the first ever Lady President, Dr Minas Rees, a famous mathematician from New York University. It was not published (NP), like two others, one about the Space Plans of the 1970s NP, and the other about Arms Control NP. However, the editors of the *Sunday Telegraph,* were more alert, the first student revolt ever at an AAAS Meeting caught their attention and my report was published under the headline "Gas and Biological Arms condemned", 25 CC.

Angry cries of "War Criminals" were hurled by militant students at their own professors and placards with "How can arms makers discuss arms control" were paraded in the auditorium. This was the great difference between the Boston AAAS and all previous ones, that the student revolt had come to the surface in these otherwise purely scientific meetings. As it turned out, speaker after speaker at the Arms Control Symposium argued for reduction of arms expenditure and international disarmament. The students objected most fiercely to arms research at their own university, the Massachusetts Institute of Technology, where a novel rocket was being designed. Although only a single missile, it was able to carry four nuclear bombs and each one of these could be targeted independently to a different enemy site. This was of course the echo of the famous student revolts which had occurred in Europe in 1968.

Pandemonium at AAAS Title 203

At the next day's symposium on 27 December 1969, devoted to the future of the American Space Program, worse was to follow and a veritable uproar ensued, when students and scientists shouted angrily at each other during the normally so sedate and conservative proceedings. Such scenes had never before been seen, and as they were being televised, serious consequences for the AAAS were forecast in my report "Uproar over Space Costs at US Science Meeting", 30 CC. The meeting degenerated into pandemonium with placards paraded, a man brandishing a knife and another reciting an obscene poem of an anti-white character. With both the chairman and the questioner having independent microphone circuits, shouting at an incredibly loud level, such phrases as "Rockets on the Moon, slums on Earth" echoed round the hall. These scenes produced deep anger in the audience, not about the dissent urged, but by the sound-level and the crudity in which it was presented.

It was by no means a unisex protest that must have been deeply felt by all, as two women presented papier-maché Moon rocks to a distinguished speaker shouting "USA first in space, sixteenth in infant deaths—What means more to you?"

The symposium organised by NASA to gain public support for its schedule of Moon flights during the coming years must have given the organisers a grim foretaste of the cuts in its budget by Congress and the cuts in the number of Apollo flights which indeed had to follow. Only the presentation of the Apollo 11 and 12 films by Colonel 'Buzz' Aldrin, the second man on the Moon, restored some order and were in contrast to the earlier rowdy scenes.

On 28 December, the following day, the opposition to the scientific establishment was more structured and detailed. "The sorry State of Science" was presented by a group of young scientists as serving only industry for profit. Four specific examples were quoted: 'Computers with built-in obsolescence'; 'Molecular manipulation of drugs without achieving greater efficiency'; 'The use of social science to persuade underprivileged people to fit into existing society, instead of bettering it'; and finally 'NASA as a governmental technique to subsidise the aero-space industry'.

In answer, an astronomer from Harvard urged scientists to 'de-mystify' science, so that ordinary people could help in changing it. Another one of my reports "Scientists oppose manned Mars Landing" was published, 38 CC. But a counter-blast "Do not ridicule Science" by Dr J. Myer, a consultant to the White House, was not favoured by the 'copy tasting' editor in London.

AAAS—Hunger, Pollution and Anti-Science Title 204

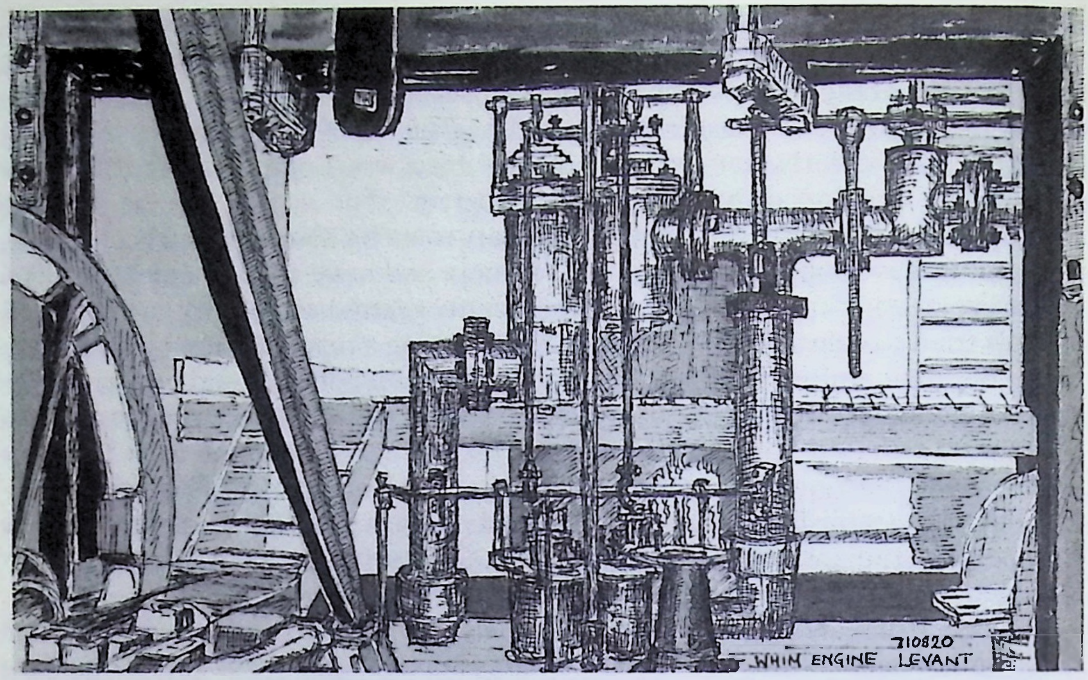
A record number of 6000 scientists had registered for the AAAS Meeting in Boston, and the Organisers were correct in choosing problems of contemporary society for discussion at the main symposia, but they lacked the foresight as to the distribution of the audiences. A vast ballroom with seats for 2000 had an audience of perhaps one dozen elderly members, where the subject was 'Engineering and Management skills developed by the Space Program'. For a talk by the famous anthropologist Dr Margaret Mead, an ordinary room for about 200 had been scheduled, but it was soon overflowing and, as more and more tried to enter, riot-like scenes broke out. Strong detachments of security guards barred entry and harassed officials tried to calm down the crowds by promising a repeat lecture by Dr Mead.

The discussion after Dr Mead's lecture centred on pollution and hunger in the midst of plenty, as well as the many social evils of the affluent American society. These were debated hotly, emotionally and scientifically, and both from the platform and the floor, indictments were hurled at the United States Congress and at the scientific establishment to allow protein deficiency diseases among the children of American Indians and, in certain places, an infant mortality as high as 51 per 1000, worse than in many underdeveloped countries.

Pollution came also under severe criticism with 7 million cars junked each year, 25000 million glass bottles and 50000 million aluminium cans to be got rid off. Margaret Mead said: "If America wanted to play the political part in the world she wanted to assume, we cannot isolate ourselves from the rest of the world and we have to show that there is no longer any hunger and malnutrition in the USA." My report was published as "Call for National Body to fight US Pollution". It was a politically soothing line! (32 CC)

This AAAS Meeting was of great significance, as it showed the beginning of world-wide and wide-spread anti-science feeling. I had of course come across it in individuals, but never before in large and vehement groups. Many in Boston proclaimed their convictions by wearing convention buttons of a blue Earth with the phrase "Love it or leave it". I discussed this anti-science movement with a learned professor who compared it with the Anti-Christ movement of the Middle Ages. When Martin Luther (1483-1546) equated the Pope with Anti-Christ, it greatly contributed to the Reformation, and one was forced to question if the existing scientific establishment was not also ripe for a reformation. I found this an interesting thought and relevant to the period.

I was back in London on 3 January 1970 after nearly 12 weeks on American territory. The year 1969 had indeed been an *annus mirabilis* for me, having travelled more than 181000 kilometers. [See Title 169]



Title 205

As long as I owned various models of Landrovers, from about 1946 until 1972, I used to spend my holidays in Cornwall, where one of my pleasures was the drawing and colouring of old **Tin-mine Ruins**, which could only be reached by Landrover. In one of these I found the remnants of a Whim steam engine, built by Harvey in 1840, rebuilt in 1860 and working until 1930. It had a 24 inch diameter cylinder. I was so pleased to find it that I drew it immediately on 20 August 1971. *Author's copyright.*

I do believe that taste in cars, just as taste in clothes, does proclaim the man, and even more so the woman. My first driving lesson I had from a book, and my first driving licence I had in 1933 in Maidenhead by simply filling in a form and handing it in at the local post office. When about six years later the law was changed and I had to take a driving test, I borrowed a small Hillman from a fellow student which had one fault, its clutch had to be operated by pulling it back by hand! Thus I drove down Piccadilly to the satisfaction of the testing official who, I believe, was rather astonished by my performance, and I had my licence for life.

The first car which was my 'own' belonged to Milton Antiseptic Ltd whose Chief Chemist I was in 1943. It was in war-time, and strict black-out regulations were in force. This meant shields with very small horizontal slits in front of the head lamps, which made night-driving exceedingly difficult. Not much later, in about 1946, I had saved a few hundred pounds, and I could buy a Landrover from a farmer for £250. It was green, had a canvas top, and was in very good condition. I was very proud of it.

It did not take long, I saved more money, sold the green car and could order a brand-new white Landrover from the Manufacturers, the Rover Company in Solihull. I specified an open back, instead of the canvas top, in fact it was a small 'pick-up' truck. I also fitted a movable searchlight on top of the cabin, which gave it a very distinctive appearance, and I was again very proud.This type, white Landrover with spotlight on the cabin, remained my standard car for many years, as it proved ideal for my purposes. I had a tarpaulin fitted over the otherwise open back of the pick-up, and could store any suitcases or other bulky items, like a large toolbox, under it. I also acquired the registration number A R M 51 for it, to give the Landrover my own initials. Every few years, I was able to order an exact replacement model, except that the last two had Diesel engines.

This style gave the vehicle an almost official appearance, which led to an amusing incident. The first Motorway, M 1, was to be opened, and I drove to the beginning of it, to report any interesting technical details for the *Daily Telegraph*. After driving a few kilometers along the brand-new Motorway, I came to a small roadside café for workmen, where I had a cup of tea. I was soon accosted by one of them, who said: "Beg your pardon, Sir, can I have an invitation to the Opening Ceremony, please!" I replied that I was not in a position to oblige him, whereupon he told me that he thought I was the Chief Constable of Middlesex. "But why did you think that?" I asked, "Well, that white Landrover with the lamp on top, could only belong to a high official!"

When at the beginning of the 1970s I became more and more friendly with a woman called Stefanie Maison, I soon began to hear comments about my Landrover, the difficulties of getting in and out with longish skirts, then fashionable. I knew that a fundamental change in my life of bachelorhood was about to begin and it was her, or the Landrover. It was of course her.

At the same time the Rover Company closed their workshops in Fulham, where Mr Frank Spalton had for years looked after my various models. He was the head of the shop and it was due to him that I had a VIP service, particularly important for the Diesel Landrovers. I found that they needed more frequent service, than those with a petrol engine, and when his attention was no longer available, it soon became disastrous. The radiator started to boil, and the repair worker of another garage could neither diagnose the reason nor effect the repair.

By the end of the 1980s, Stefanie had a Honda Civic which was renewed every second year. I bought one of the two-year old models very advantageously, and must admit that the evolution from Landrover to a Honda Civic, was not altogether an unpleasant one. Although no longer having a searchlight, the comfort and its remarkable acceleration were definite advantages, but it was not the awe-inspiring white Landrover, which gained respect and avoidance from London taxis. I was then 65 years old.

We had reached the pleasant but rather extravagant position of having two Honda Civics in the family, and Stefanie's had to be parked near her office at a most exorbitant parking rate. She decided to commute by taxi and we both agreed that a single, slightly larger car, a Volvo, would suit us well. I followed the same principle and had it regularly serviced by a Volvo Garage and never had any mechanical trouble with the several models I owned during the next two decades—until we moved abroad in 1996. [See Title 408]

And how does my taste in car's define my person? Conservative! Uppermost in my selection was mechanical excellence. With advancing age, love of comfort became important, and one smash with a Volvo proved to me that, had I been in a Honda Civic, I would have been badly injured. Nothing happened to the Volvo, and had the drunken driver of a small truck who cut in front of me, escaped and was untraceable by the police. Safety had become also desirable in later life.

From Botany Bay to the Moon Title 206 A

This was the title of a Leader Page article (63 C-C) which was published on 28 March 1970 to commemorate the Bicentenary of Captain Cook's landing in Australia. The event was widely celebrated in England and in the Antipodes by Museum Exhibitions and special issues of scientific journals. However, my contribution, comparing Cook's achievements with those of the Apollo astronauts, up to Apollo 12, was to say the least somewhat unusual.

There are several similarities. Cook's first voyage in HMS *Endeavour* 1768 -1771 had an official scientific objective, to observe the solar transit of Venus, but secondly he had secret instructions to discover and claim for England any new territories before France or Spain could do so. The Apollo flights to the Moon were also primarily for scientific discoveries, but also with the political objective to forestall the Soviet Union in reaching the Moon first and making possible territorial, political or prestige claims.

The enormous difficulties of accurate navigation, both for Cook in the completely unknown Pacific Ocean and for Apollo 11 across 400 000 km of space and then landing on a precise location on the Moon, may also be compared. Cook had the first *Nautical Almanach*, published one year before his sailing, which contained the vital lunar distances between the Moon and the stars, to be measured by sextant, to give him the longitude. He also had the first portable Marine Chronometer, Harrison Number 4, for longitude, but both were completely new and had never been tried before over such vast distances. With these meagre tools, Cook navigated precisely and then surveyed accurately the coasts of New Zealand and Australia, producing maps which were not superseded for more than a century. On Cook's second and third Pacific Voyages, he proved the Marine Chronometer's great superiority over lunar tables and thus added much to Harrison's reputation.

The accurate navigation across space by the Apollo astronauts also had to rely on the position of the stars, to check the accuracy of their electronic instruments, equally new and untried. Apollo's flight direction indicator and the DISKEY computer were simple to operate by pushing buttons and did not require hour-long logarithmic calculations with pencil and paper, as Cook had to perform. Yet when Apollo 11 landed on the Sea of Tranquility on the Moon, the precise position of its landing site could only be determined from photographs many weeks later.

Cook's other great achievement, to preserve his crew from scurvy, made him the equal of Drake and Nelson in the History of British Seamen, as Lord Blackett, President of the Royal Society, put it in his address when honouring the 200th Anniversary of Cook reaching Australia.

Returning to the Office of the *Daily Telegraph* in Fleet Street, after the excitement of Apollo 11 and the grandiose voyage to the Antarctic, was a real anti-climax. Routine science stories had to be covered and life in London had to be restarted. I had brought back from the Antarctic an unexpected souvenir, an inguinal hernia in my groin.The routine surgical operation was arranged in the Fitzroy Nuffield Hospital, Bryanston Square, for 8 April 1970.

I did not expect the date of my operation to coincide with any space flight. Apollo 12 had been launched on 14 November 1969, and apart from a precision landing on the Moon, next to a previous spacecraft, Surveyor 3, from which it brought back to Earth certain parts for analysis, it was a faultless performance. Apollo 13 had been prepared for a launch early in 1970 but was sitting at Cape Kennedy waiting, and its flight was postponed time and again for the rectification of a number of minor faults.

Apollo 13 was launched on 11 April, and 56 hours after launch the ominous message from the spacecraft "Houston—We have a problem" was broadcast. A liquid oxygen tank in the Command and Service Module, CSM, had exploded, destroying not only the supply of electrical power, but also the oxygen supply for the atmosphere in the CSM. It was indeed a very serious problem, and I was immediately telephoned in Hospital by the Foreign Editor who asked me if I was well enough to comment. I was able to do this thanks to the BBC which broadcast an almost continnous television report from Mission Control in Houston about Apollo 13. I had nothing better to do than to watch it, day and night.

The following comments of mine were published: [C-C = Column Centimeters]

15 April	METAL FATIGUE MAY HAVE CAUSED CRISIS IN SPACESHIP	38 CC
	'PAIN KILLERS' IN APOLLO MEDICAL KIT	
16	NUCLEAR GENERATOR 'HARMLESS' WHEN MODULE BURNS	27 CC
17	APOLLO MEN FACE 3 MORE CRISIS MANOEUVRES	82 CC
18	LUCK AIDED SKILL AND COURAGE IN SAVING MOON MEN	50 CC
20	EXHAUSTIVE SEARCH FACES EXPLOSION INQUIRY TEAM	49 CC
21	EXPLOSION DAMAGE WHICH LED TO NEAR-DISASTER IN SPACE	37 CC + 3 large pics

By this time I was discharged after my operation and in recognition for my reports from Hospital I received from the *Daily Telegraph* a generous bonus.

The final explanation of the explosion of the oxygen tank in Apollo 13 was disclosed several months later. To change the liquid oxygen at -183 °C into gaseous oxygen, a small electrical heater is built into the tank which operates intermittently, whenever the demand arises. A contact-breaker is therefore incorporated into the electrical heating circuit.The breaker has two platinum contact points. As the launch was delayed over several months, during which constant tests of all equipment had been carried out, these contact breaker points had welded together and a continuous heating of the liquid oxygen took place, which as a result led to the explosion. Once the cause had been determined through lengthy detective work, which was only possible by analysing the voluminous paper and computer records accompanying all spacecraft tests, a small redesign avoided any repetition.

My comments from hospital must have stood me in good stead with the Editors of the *Daily Telegraph,* because when I applied for a month's leave to attend my eldest daughter's wedding in New Zealand, it was readily granted. I could only finance such a tour by writing a report about "New and Unusual Mineral Resources in South Africa and New Zealand" for the firm of Metal Traders in the City of London. I started in Israel because I knew a mineral expert there who could help me to locate new resources in South Africa, a country with which he had kept in close touch.

I also interviewed Professor Ari Ben Menahem of the Weizmann Institute in Israel, then one of the leading earthquake investigators, and my story was later published in the newspaper. Like many other Israeli scientists, he wanted to make his point by telling a parable from the Bible. "A rich old farmer was lying on his deathbed and told his two sons that there was a treasure buried on his land; but before he could reveal its location, he died. His two sons started to dig and continued for years, but never found the treasure. But their digging made the land fertile and they became rich." Ben-Menahem's 'digging' consisted in transferring the volumes of seismic recordings issued by the US Coast and Geodetic Survey to his computer and by their analysis he hoped to find indicators which might lead to earthquake predictions. But he was not lucky.

To travel east from Israel was not easy in 1970, and I had to go through Teheran, New Delhi, Bangkok, Singapore, Darwin to Sydney. This time my flight from Sydney to Wellington in New Zealand was not eventful like my previous one, 15 years earlier. [See Title 46] I arrived in good time for the wedding and afterwards devoted myself to the task of interviewing geologists and other knowledgeable scientists. I had a minor handicap on the whole journey, as after my hernia operation I was not allowed to lift my luggage and frequently had to ask for help. The reply was often: "What a pom, he can't even carry his own bags!" But my appeal was always answered.

Before leaving Sydney I visited the Australian Subsidiary Company of Metal Traders of London and received, as arranged, a valuable technical briefing of what my final report was to elucidate.The questions which these far-sighted traders were anxious to explore, were indeed extensive, and they reminded me of those anyone would ask before beginning any ordinary scientific experiment. I made a long list and was able to reply to most of them in my final report.

Basic to all were financial and legal questions. Could minerals or their products be exported, like coal? Did Development Allowances exist, like a 40 % claim? Was there a Tax Holiday for the first 3 years of mining? What was the NZ Government policy on foreign investments and technical help, was it welcome? Is Japanese capital, through Metal Traders, acceptable? Does NZ require native interest in its company law? What is preferable, to buy production or the mine? And so on and so forth.

The technical questions were of course much more detailed. Did sulphur occur in commercial quantities and was it already exploited? Are there any coking ovens in NZ, as there exists a Japanese interest in this product? Who is working or only exploring the Iron Sands? Can production of copper sulphate, used as trace element for fertilisers in West Australia, be doubled for a market, if they exist and how is it produced in NZ ?

Many questions were concerned with specific metals and minerals, as for example copper and its ores, chromium, tungsten, antimony, lead, tin and platinum. New Zealand's surplus hydro-electricity could perhaps lead to the building of an industrial complex around it, as bauxite smelting from Weipa in North Queensland [see Title 192] is already being done. What were the future plans for extending hydro-electricity? I was also asked to investigate the commercial situation with regard to large gemstones for carving, like jade, green stone and opalite.

I found many, although by no means all, answers at the Geological Survey in Lower Hutt, at the Department of Electricity in Wellington, at the DSIR Chemical Division in Petone and at several private companies to which I had introductions from London or from Sydney. I flew back through Sydney, Perth and Johannesburg to London. In Perth I came across a Wild-West nickel rush of armed prospectors, anxious to stake their claims for nickel ores. A long ban in West Australia on pegging claims was suddenly removed, and all available helicopters had been charted by mining companies who had organised their own military operations. The right end for my mineral quest!

I cannot now remember why I was asked to give several lectures during 1970. The only possible reason I can imagine is the fact that my name appeared prominently on the front page of the *Daily Telegraph* during the Apollo 11 reports in the previous summer.

I was asked to talk about "Science in Fleet Street" by the Chemistry and Physics Society of University College in Gower Street, London, on 27 January. I kept my notes, a few headings and see now that I started with the technicalities of writing, typing and transmitting by letter, cable, telegram, telephone and Telex—there was no Fax yet in those days. I stressed the social responsibility of a science writer and quoted my articles about chemical and biological warfare, the need for a Thames Flood Barrage and for television from satellites for the education of people in the Third World.

I mentioned a few scoops like the maiden voyage of the atomic ship *Savannah* and Nancekuke and my unusual bylines, like the South Pole. All these subjects were easy to talk about, as they were of recent memory and I was eager to tell others about them. Far more difficult was my description and suggestions for the greater scientific and technological efficiency of newspaper production. It was still in the days of metallic Linotype setting, and I recommended the use of computers for typesetting, which of course came about a few years later.

I finished by speculating about a world newspaper, also reality today, like the *Financial Times* and *Wall Street Journal,* printed identically in different Capitals of the World and at the same time. My pet idea of a *Daily Science Newspaper* has not yet been realised and may never happen, although I am sure that a readership of scientists, engineers, managers and opinion-makers world wide, would be large enough to give a financial return for such a novel enterprise. I repeated this lecture elsewhere several times to various audiences.

On my last visit to Texas I was elected a Member of the Anglo-Texan Society, in fact I was nominated an "Admiral of the Texan Navy", an honorific title of no significance. At the London Headquarters of the Society, meeting at the English-Speaking Union in Charles Street, Berkeley Square on 3 March, I showed the film record of the Apollo 11 Saga, which had been kindly given to me by NASA, the American Space Agency. At the time, interest in space was still great, and it was easy for me to answer the many questions posed after the end of this excellent 40-minute film. Many of the audience were Americans living in London, and naturally they were as proud as I was of this extraordinary triumph of American science and technology. I also showed the Apollo 11 film to members of the Savile, my Club.

These activities were ego-trips to show my scientific Temper!

The subject of my next lecture on 6 July 1970 was "Antarctica" and the audience was composed of 'Young Conservatives'. It must have been a sub-group of the Conservative Party, but as I do not belong to that party, I can only presume that I was persuaded by a member, whom I can no longer remember, to talk to their young hopefuls, including perhaps a few young scientists.

The Antarctic Continent, from which I had just returned, was a subject I liked and about which I had read a great deal in my large collection of old books dealing with the Antarctic. Perhaps I had the intention of inspiring the young scientists in the group to go out and explore for themselves, when they had heard what adventures had befallen earlier scientists in the Antarctic—but I do not know if I succeeded. I can't even recall where I lectured.

I started of course with Captain James Cook, a Fellow of the Royal Society, whose superb skill in navigation allowed him to reach 72° south in 1772-1775, during his second voyage to those regions. I stressed the fact that exploration during the Heroic Age, and ever since, had been a very international enterprise. The first to spend a winter season in the Antarctic was the Norwegian C. Borchgrevink in 1894 and the French explorer Charcot who followed him in his ship *Pourquoi pas?* in 1908. Then there was the German glaciologist, Drygalski, who as the first in 1901-1903 led an international expedition, overwintered and published his results in 20 volumes.

The British heroes, Shackleton and Scott, the American Peary (incidentally not the first man to reach the North Pole) and the Norwegian Amundsen were all discussed in my lecture dealing with the Heroic Age, before turning to modern exploration by air and the American Admiral Byrd who flew to the South Pole in 1929. I mentioned Antarctic tourism and finally compared the conditions on the Moon with those in the Antarctic and how this partial similarity might be exploited for training eventual settlers on the Moon.

My fourth and last lecture of that year, on 18 November, dealt with "Rocket Cinematography" and was given at the City University in London E.C.1. It was based on a chapter of the second volume of my book on *Research Films*, which was written, but never published. I discussed the history of rocket flight and the important role which cinematography played in recording the all-too-frequent failures of the early rockets for subsequent analysis and technical improvements. The best examples for this was the development of the German A 4, or V 2, rocket which attacked London and southern England in 1944.

Title 212

Professor Otto Kinne, Director of the Marine Biological Institute of Heligoland, next to the terraqueous globe, his finger pointing to Heligoland. After several visits of mine I invited him to join the ISR Editorial Board. *Courtesy O. Kinne.*

Travel in 1970 was not as exciting as in the previous year and was confined to Europe. In March, one of the most successful visits to German science took place, arranged as usual through the courtesy and efficiency of the German Science Counsellor in London, Dr Hans Mohrhauer, and of Internationes, the German Government Travel Agency. [See also Title 168]

Our first call was to Heligoland, the Island off Hamburg in the North Sea, where Professor Otto Kinne, an old friend of mine and later member of the Editorial Board of *Interdisciplinary Science Reviews,* greeted us warmly. As Director of the Marine Biological Station he told us about his efforts to breed lobsters in 'Battery Farms' to reduce their natural life time growth from 12 years to three. As lobsters do not grow naturally during the winter, warmer water was essential, and he hoped to obtain this from the hot outflow of the cooling water at atomic power stations.

As regrettably nothing has come of this worthwhile research project and as lobsters are still as expensive as ever, I can only now assume that the German widely distributed posters: "*Atomkraft—Nein danke*" [No thank you for Atomic Power] also played their part in refusing us cheap lobsters. It was a good and not too difficult project, and it was published as a story in the *Daily Telegraph.* [25 C-C]. Another example of *Atomophobia!*

From the north to the south of Germany, to Erding near Munich, where at the Max-Planck-Institute for Behavioural Physiology, Dr R. Wever had discovered that an alternating current could shorten the human body's 24 hour natural rhythm by one hour. He envisaged that this change in the biological clock would help travellers suffering from jet-lag. At this beautiful Institute, on the shores of a deep lake, surrounded by pine forests and snow-covered mountains in the background, I met Konrad Lorenz, the Grand Old Pioneer of the science of animal behaviour, famous also for his geese, following him in a file as he walked along the lake. My article, entitled "The Father of Animal Studies" was 39 C-C long.

Then onto Bonn, where at Schloss Birlinghofen, the Society for Mathematics and Data Processing was planning a super-computer to give the then Chancellor, Herr Willy Brandt, instant and comprehensive knowledge of all work going on in the German Ministries.

The other European visits of the year were to the Shell Research Laboratories in Rotterdam, to the Frankfurt Book Fair, the Basle Institute of Immunology and to Sweden in November, where I saw and reported on some interesting novel engineering of materials generated under extremely high pressure, to be used for example in stronger and harder gear wheels.

I have already given four lists of scientific articles which I consider as routine. The material for these stories came to me so easily that it meant more editing than writing. Because the subjects of my reports were so very varied, I am once again listing these, here for 1970, to indicate the multitude of scientific aspects which have to be covered during an average year of work in Fleet Street. [For previous Routine Science see Titles 95, 115, 139 and 156]

ARTHUR C. CLARKE HONOURED
NORTH SEA STORM SURGES ENDANGER LONDON
RUSSIAN 'SPY IN SKY' IMPROVED
GULF STREAM MISSION – KON TIKI – FINAL REPORT
METHANE DISCOVERED IN MOON ROCK ANALYSIS

RUSSIAN ICEBREAKERS DRIVEN BY ATOMIC POWER
ELK TRACKED BY SPACE SATELLITE
NIXON'S GO-AHEAD FOR GRAND TOUR OF PLANETS
FROM BOTANY BAY TO THE MOON [Feature see Title 206 A]
BRITAIN'S ROLE IN GAS CENTRIFUGE PROJECT

REVERSED BRAIN DRAIN FROM AMERICA TO ISRAEL
GAS PIPE LINE BURIAL UNDER NORTH SEA
POISONOUS SMOG IN TOKYO
INTERNATIONAL ASTRONOMY UNION IN BRIGHTON [14 Reports]
SOUTH POLE ONCE IN SAHARA

DANGER GROWS OF LONDON FLOODING
INCA SIGNS DECIPHERED AS SCRIPT
APOLLO CUTS WILL CHANGE LANDING SITES
NATIONAL VEGETABLE RESEARCH ASSOCIATION
BRITISH ASSOCIATION, DURHAM [30 Reports]

LUNA 16
NASA GOES METRIC
SCIENCE FOR PEACE IN MIDDLE EAST
MELBOURNE BRIDGE COLLAPSES
LORD ROTHSCHILD RETIRES

QUEEN'S SECRET AIRSTRIP IN LONDON PARK
FIRST WHEELS ON THE MOON
EINSTEIN VERIFIED BY MARINER 6 AND 7
WOOMERA TO BE ABANDONED AS SPACE BASE

The new year of 1971 was certainly full of interesting scientific events. The faultless American Apollo 14 flight to the Moon was in stark contrast to the disastrous failure of the European satellite launch in Kouru, French New Guinea. England's century old currency went metric, and I launched my successful currency converter. [See Title 78]

The Apollo 14 launch date was set for the end of January and the Lunar Science Conference, also in Houston, for the middle of the month. I discussed with Ricky March, the Foreign Editor of the *Daily Telegraph,* the advantage of spending the month of January in the USA, to which he readily agreed.

I started in Washington as usual, staying as a guest member at the famous Cosmos Club to which I was elected as a full member in 1986, [See Title 306] and there picked up an interesting discovery of Professor Gary Thomas of the University of Colorado. It was a giant hydrogen gas cloud in our galaxy, estimated to be 80 thousand million kilometers long, which his team had found but considered of no danger to Earth. At the University of Maryland, near Washington, I heard of the difficulty which British scientists had in contributing to the exploration of the Moon, simply a question of money.

At Mission Control Center in Houston, on 9 January, the last Press Conference before the launch of Apollo 14 took place, and I reported that full safety precautions had been taken to avoid a recurrence of the Apollo 13 disaster. There was also some criticism by the Apollo 14 astronauts that the whole of the American Space Program was not properly supported, neither by the Government nor by the American public. The cut-back on the Apollo programme was like "Buying something and then not using it" as Navy Commander Mitchell, one of the astronauts, put it.

The Lunar Science Conference dealt with numerous subjects, and I reported many of these, but only three were published:

	Column centimeters
MOON WIND FILLED UP CRATERS	16 CC
IRON OXIDE FOUND IN MOON ROCKS	18 CC
NUCLEAR ROCKET ENGINES FOR PLANETS [See Title 102]	21 CC

Apollo 14, launched on 31 January, had some trouble in the docking of the Lunar Module with the Command Module but finally succeeded. The astronauts landed in the Lunar Highlands and carried out extensive walks, thus wiping out the bad reputation of Apollo 13. My reports and analyses were published on the front page with pictures.

On my way to Houston, before the Apollo 14 launch, I reported on one most unusual event. An American millionaire, Robert P. McCulloch, on a visit to London, decided that a London Bridge would be an ideal attraction for his new town, Lake Havasu City, in Arizona. He liked the grandiose Tower Bridge with its two sections of the road, the bascules, which can be raised to let steamers pass below. He was convinced it was the 'London Bridge', bought it for £1 million to be re-erected at Havasu—at least so I was informed when I went to Arizona. What he had bought from the City of London, was however the old 'London Bridge', a multiple-arch bridge composed of large Cornish granite blocks.

I saw it nearly completely rebuilt, stone by stone, in Arizona, the blocks having been shipped from London's Surrey Docks to Long Beach Harbour in California and from there trucked 550 km over the desert. The granite was still black and covered with soot, accumulated since 1845 when John Rennie (1761-1821), one of England's great engineers, had built it. The desert Sun of Arizona will soon bleach it and the desert sand storms will give it a gentle sand-blasting, so that in a decade or so, it will again stand in its original pristine condition, to last for several more centuries, I wrote.

The Colorado River, instead of the Thames, will flow below the bridge, once it has been completely erected. It was considered cheaper and easier to rebuild it on dry foundations and divert the river, than using the alternative of sinking foundations into the flowing Colorado. When I saw it, it was still standing on dry desert sand as the picture showed which was published with my story in the *Daily Telegraph.* In Fleet Street, my report was thought to be a good 'local story'.

From Arizona I drove on in my hired Hertz car to two great research laboratories of NASA, the Jet Propulsion Laboratory, JPL, in Pasadena, California, near Los Angeles and the AMES Laboratory near San Francisco. At JPL I saw the painstakingly detailed computer design of the spacecraft for unmanned exploration of the solar system, all of them individually constructed and engineered by hand at JPL.

They had started with *Ranger* and *Surveyor* for the Moon and followed with various *Mariner* spacecraft for the exploration of Mars. Future *Viking* spacecraft to look for life on Mars, due to be launched in 1973, were still in the early stages of conception.They were planned to eject a *Lander* from Mars-orbit, which would move over the Mars surface and with its long scoop collect samples of soil. These were to be analysed on the spot in the *Lander* for photosynthesis and bacterial growth, before similar Russian experiments could be carried out. But the results were negative.

See also watercolour Title 165, inside Front Cover

On 15 February 1971, decimal coinage became (for the second time) legal tender in Britain, and four days earlier my historic article, entitled "A spot of trouble?" appeared in the *New Scientist* on page 320. It gave the history of the decimal point, from the earliest place notation and the invention of the figure '0' by an unknown Indian mathematician, through Napier's use of the decimal point in his *Constructio* of Logarithms (1619), through the establishment of the Metric System during the French Revolution, to the first English metric coin, the florin [one tenth of the Pound Sterling] permitted by the Metric Act of 1864, repealed after 14 years, and allowed again in 1897.

As a scientist I had of course used the metric system all my life in all my work, and I was an ardent supporter of its introduction to Great Britain, particularly as my friend and colleague, a science writer, Ritchie Calder (later Lord Ritchie-Calder) had been appointed Chairman of the Metrication Board in England. What interested me most was the history of the Metric System, and I was able to collect the primary literature on the subject.

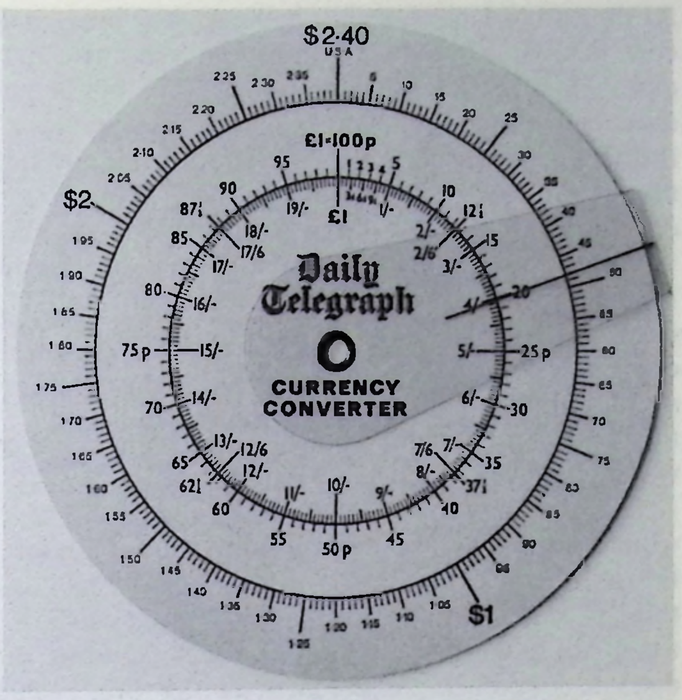
As for example an original copy, 4 pages, of the French Law of 22 August 1790, when the King, Louis XVI, invited the King of England to support him in asking the British Parliament and the Royal Society to collaborate with the National Assembly of Paris and the French Academy of Science, jointly to fix the eternal standard for all weights and measures. Unfortunately this invitation was never accepted, and so French scientists alone measured carefully the length of a quarter of the me-dian and laid down that one ten millionth of this length should be the meter. This ginal document was one of the most precious items in my collection of books on history of science.

The conclusion of my article was an attempt to derive a lesson from this 200 year ong struggle to introduce a new and better system of calculation to the people of Europe. (In France it had only taken 50 years!) It became quite obvious that men, and women are extremely reluctant to change anything, and if this change costs money, they will bitterly oppose it.

I then foresaw that a long-drawn out struggle would loom ahead for the introduction of an international European currency and that it would be quite impossible to use one of the existing currencies for it as the new unit. It had been equally impossible to use one of the many existing weights and measures in 1790 as the new standard, and a novel unit, the meter, had to be invented. At the time of writing these lines, the long struggle seems to come to a successful end and the invention of the new currency unit, the *Euro,* is simply repeating history. Instead of using gold for the security backing of the new currency, I even suggested that Plutonium, the most valuable of all man-made materials, should replace it!

Title 217

The Converter of the old English £-s-d currency **to the new decimal notation** was the Author's only invention, but instead of patenting it, he transferred all rights to the *Daily Telegraph*. Many thousands were sold and the Author received royalties. The model illustrated has a US $ ring added on the outer circumference, giving the Converter an additional usage for American visitors to Britain. The cursor indicates the equivalence 4/- shillings, 20 new pence and 48 US cents, when in 1971 the rate of exchange was US $ 2.40 = £ 1. © *Author.*



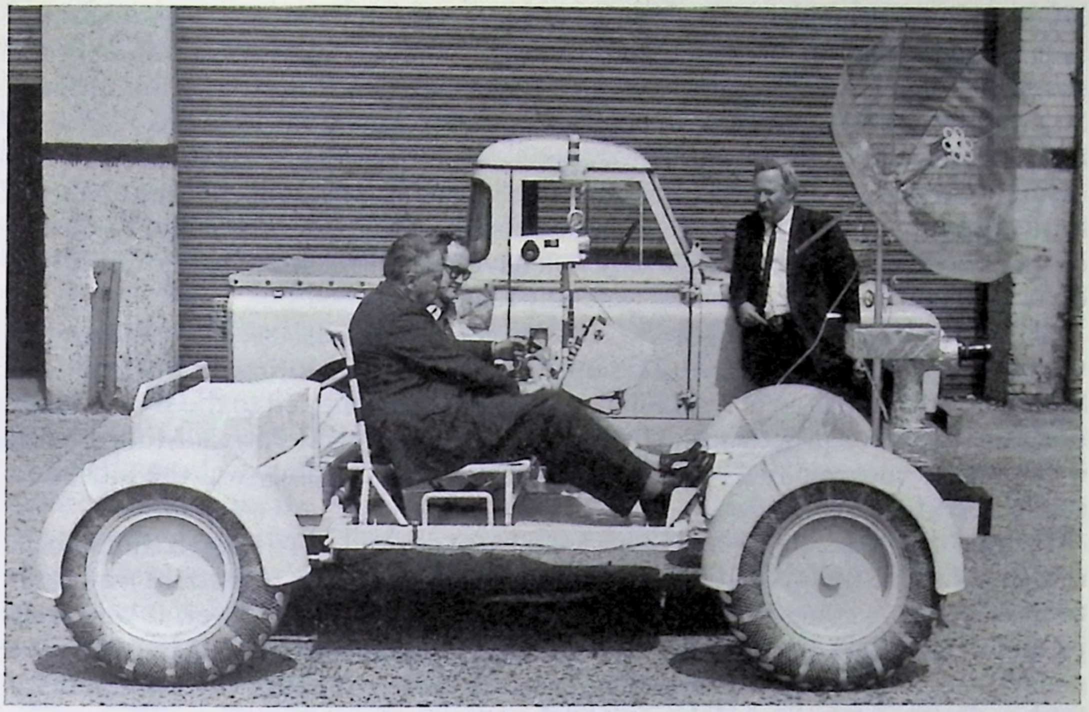
At the end of January 1971 I had made my own small contribution to Britain's new currency, while in the USA President Nixon tried in vain to conquer all cancer diseases. He offered $ 100 million to prevent the then annual death of 300000 Americans from all types of cancers, and he was quoted as saying "If we can put men on the Moon, we can cure cancer on Earth". It is now quite obvious to all scientists that money can buy technological miracles, whereas great advances in biological knowledge can only be achieved by basic science research over decades.

Without such advances in biology, as they are now gradually accumulating, [see Title 368], no cancer cure will ever be discovered. Of course if there is no basic science, technological miracles are also impossible. It has always been a disgrace that our great statesmen, with the exception of Benjamin Franklin, Chaim Weizmann and Jawaharlal Nehru, never had a scientific education to grasp the simple distinction between basic and applied science, and what can be achieved with their aid, when employed intelligently and efficiently.

The idea of a converter from the old to the new British currency came to me when I looked at a very beautiful reprint of a book, *Astronomicon Caesareum* by Petrus Apianus (1495-1552), originally published in 1543 [see also Title 78]. It contained a series of splendidly hand-coloured volvelles, the circular paper discs, graduated along their circumference, which could be rotated against other concentric discs inscribed with further facts. Two or three such discs were mounted concentrically with a small pin on a page of the book and a coloured thread of cotton acted as a cursor. Apianus, a German astronomer and cartographer, was famous for the maps and illustrations in his many books and obviously used volvelles to facilitate astronomical calculations.

What could be easier than to have a circular disc with the New Currency on the outer circumference, £ 1 = 100 NP (New Pence), and the old Imperial currency on an inner, also central ring, both printed on the same piece of plasticised cardboard, no rotation needed. Only a single transparent plastic cursor was required to find the equivalents of old and new values.

Once I had made a simple rough prototype, I discussed it with my great friend Lord Hanworth, whose engineering knowledge I greatly valued. He advised me against seeking a patent for the converter, time was after all pressing and suggested I obtained a sponsor for the gadget. I could think of none better than *The Daily Telegraph* who accepted the idea, advertised, marketed and sold it most successfully in two sizes, 8 cm and 11 cm diameter respectively, as a copyright article with its own imprint and my name on each item. I received a good royalty from the considerable sale of these converters.



Title 218

When the BBC had a training version of the Moon Rover shipped to London to add reality to its television transmissions, the Author (leaning on his own white Landrover ARM 51) had a chance to compare the two vehicles with Patrick Moore (nearer the camera), the astronomer and commentator on the Apollo 15 program and James Burke, the Link man (sitting next to Patrick) a few days before the Apollo 15 launch 26 July 1971, during rehearsals. *Courtesy BBC Television.*

Apollo 15 was launched from Cape Kennedy on 26 July 1971 and was the second longest flight of the series, a total of 295 hours, 11 minutes and 53 seconds, only surpassed by Apollo 17, the last ever, with a flight time of 301 hours, 51 minutes and 59 seconds. Apollo 15 was also the first spacecraft to take a car to the Moon, to extend the range of the exploring astronauts.

Of all the 'firsts' which the Apollo technology demonstrated, the Moon Rover, or the 'Buggy' as it was soon called, was one of the most remarkable and its electrical drive with electronic controls may well have foretold more of the future of the ordinary family car than has been generally realised.

Called the 'Lunar Roving Vehicle', LRV in NASA's officialese, four of these cars were built, jointly by the Boeing Company and General Motors, at a cost at that time of £350000 each. When a training version of it was shipped to the BBC in London for a television programme, I had a chance, together with Patrick Moore, to see it in close-up and even ride on it for a short distance. It certainly was the most unusual mode of all my travels.

It could drive a total of 5 km in a straight line at a speed of 16 km p h. It had been calculated that 5 km would be the longest distance the astronauts could walk back to their Lunar Landing Module in case of a break-down of the Rover. It was transported to the Moon as an outside attachment of the Lunar Landing Module, and it needed no more than a pull on two thin ropes by the astronauts, to detach and unfold itself automatically and drop on to the lunar surface. This alone, its mode of transport to the Moon and its own erection, was a great engineering achievement, I wrote.

On Earth the Rover weighed about 225 kg, 37 kg on the Moon and was designed carry twice its own weight on the Moon. (On Earth an ordinary car carries about e half of its own weight.) It could manoeuvre slopes of 25 degrees inclination and , non-rechargeable silver-zinc batteries gave it a 78 hour lifetime. Its four wheels, 2 cm diameter, individually driven electrically, and each steerable, were constructed from steel piano wire, woven into a flexible mesh structure. With them, the Rover could negotiate steps 30 cm high. In case of breakdown, each wheel could be electrically uncoupled.

The most unearthly part of this strange vehicle is its complete computer control, showing headings, bearings, distance travelled in kilometers, range and sun shadow indicator to correct for drift of the inbuilt gyroscope. Its speedometer, also calibrated in kilometers, gives an accurate reading, whether moving forwards or backwards. An electric vehicle of the future will certainly have many of its features. The Rover was highly successful on the Moon. Previously I had driven it in a simulator during a visit to Grumman, Title 135.

Already before the launch of Apollo 14 in July 1971, the end of the manned exploration of the Moon had been announced. It was to finish with Apollo 17 in December 1972, I learnt at the first British Moon Conference at Newcastle-upon-Tyne at the end of March 1971. The Conference, organised by Professor S.K. Runcorn of Newcastle University, heard from leading American space scientists what the plans were for Apollo 15, 16 and 17, but also that this would be the end. Apollo 18 and Apollo 19, planned originally by NASA were cancelled by the US Congress. The total length of American manned Moon exploration would thus be only three years and five months.

I found the discussions about the origin of the Moon most interesting and reported fully about these to my newspaper. Present at the Conference was Emeritus Professor Harold Urey from the University of California who had received the Nobel Prize in 1934 for his discovery of deuterium, the isotope of hydrogen. I had met him several times at La Jolla in California where he lived in quiet retirement, and later I invited him to join the Editorial Board of *Interdisciplinary Science Reviews,* which he graciously accepted. He was one of the kindest persons I ever met, immensely learned, of a world-wide reputation, but no longer as fit as he had been. Once when I visited him in La Jolla, his wife received me and urgently asked me to help her lift her husband from the floor where he had fallen and was unable to get up. I was glad to render this small service to him. He died in 1981.

It was due to the great reputation of Runcorn that Urey, then 78 years of age, came to England to speak about the origin of the Moon at the Newcastle Conference. From his work on deuterium he had moved on to the heavy isotope of oxygen-18, to the origin of the elements and to the age of the Earth and of the Moon.

Various theories had been proposed about the origin of the Moon, before and at the Conference, but Urey was of the opinion that the Moon had been 'captured' b the Earth. "Imagine what a very special situation this would give to the Earth. If th Moon had developed independently from the Earth, it might well be much older Urey said. The theory that the Moon had been torn out of the Earth by giant tides was according to Urey "mechanically doubtful. The loss of volatile elements from the Moon, for example mercury which had not been found in any Moon rocks, makes me very skeptical about this theory" he said.

"If the Moon had been captured we could get observational data on the origin of the whole solar system" was Urey's final conclusion in March 1971 at the British Moon Conference in Newcastle.

In May 1971, I was once more invited to take part in another visit to West Germany by its Science Ministry, following the previous ones, [see Titles 168 and 212). Although the general briefing on German science policy took place at the end of the visit in Bonn on 11 May, it will be best to review it first and then the impressive background of what we had seen at the beginning.

In Bonn our group of British Science Correspondents met Dr W. Finke, the Head of Economic Planning at the Federal Ministry of Science. He told us that Germany was determined to reach again the high standard of science which it had lost during the period of the Hitler Regime and World War II. Now, after their *Wirtschaftswunder,* the phase of economic recovery, science could once again receive priority. The recovery had been due to hard work at all levels of the population, following the 'Marshall Plan' and currency reform.

A growth rate of the science budget of 35 % per annum during the years 1971-1974, was then being planned and would be achieved Dr Finke explained.The first result of this priority plan was a massive return of German scientists and engineers from America to ameliorate the major shortage of natural scientists as university teachers. Amongst the ambitious new projects he outlined were the building of two new oceanographic research vessels, the launching of two satellites, one scientific and a second application one, a special station to evaluate new desalination techniques and transportation research for magnetic levitation inter-city trains at a speed of 500 km p h. This famous 'Maglev' project was developed but cancelled in 2000, after 29 years of research.

Our group met at Heathrow, London's main airport, flew to Munich and directly proceeded to the Zugspitze, Germany's highest mountain, 2963 meters, which we reached by a comfortable ride in a rack and pinion railway, mostly built inside the mountain itself. On top and also inside the mountain, the Fraunhofer Society had established its research laboratory for the collection of meteorological data and for monitoring atomic fallout from nuclear tests. So for example the scientists there found that it took seven days for fallout from Chinese tests to reach the Zugspitze. The total solid matter in the air was also measured to determine lead pollution.

Our next stop was in Tübingen at the Max-Planck Institute for Virus Research, where I was much impressed by its precautions against contamination. Before entering the laboratories I had to pass through an air-lock with a 2.5 cm layer of disinfectant on the floor. Even at the Biological Warfare Laboratory in Porton, [see Titles 160 and 161] there were no such measures. In an emergency, the Tübingen Institute can be sealed completely and is self-contained. At the time new and highly infectious virus diseases, like Ebola and Marburg, had been discovered and caused great concern about secure isolation.

A thrilling highlight of the German visit—never to be forgotten—was an all-too-brief ride in a Mercedes Benz prototype sports car C 111, at a speed of 300 km p h (190 m p h). The Company had a private test track where one of their test drivers took all of us, individually of course, for a spin in their latest model. The circular track was short and had two highly banked curves where one really felt being pressed down heavily into one's seat by the high speed. I actually experienced what a Formula 1 driver undergoes during a race.

This opening gambit of our invitation to Mercedes Benz was simply meant to impress us with their massive research and development effort, employing at the time 6800 people at their world-famous Untertürkheim Establishment. Other splendid statistics, which of course we had no means to verify, were given to us by Professor J. Förster, the Director of R + D, who told us that in 1970 they had produced 280000 passenger cars and 150000 commercial vehicles and that this output was double of what had been manufactured five years previously.

Their research philosophy effort was admirable: The car was to serve as an enrichment of life, but only if accidents, noise, air pollution and waste disposal could be reduced to a minimum. Such aims demanded high engineering requirements to increase safety, a reduction of fatigue and a safe packaging of the driver and passenger to ensure survival after an accident.

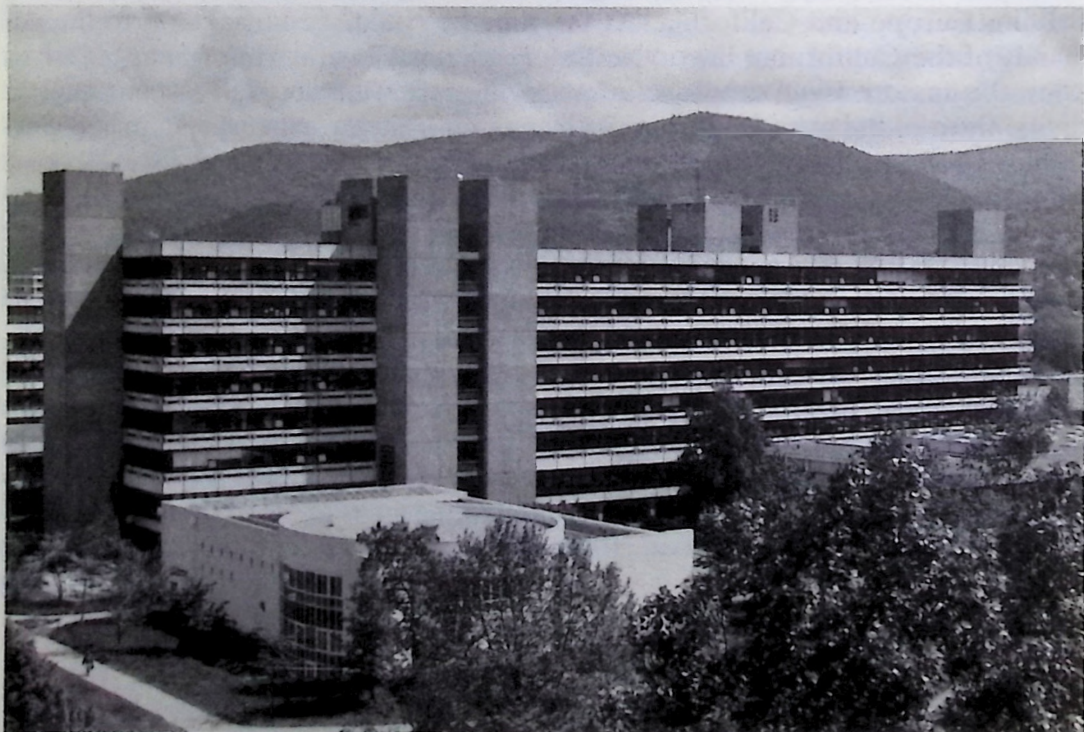
Professor Förster was not so enthusiastic when he discussed the reduction of exhaust pollution. It was a difficult subject, he told us, with different standards set by Britain, Europe and California. At the time he could see no solution to the demands of the Californian laws: "Neither Ford, nor General Motors, nor ourselves know the answer. Even simple solutions giving partial answers will cost one quarter to one third of the price of the car, such as catalysts in the exhaust system and electronically controlled fuel injection."

[Since the date of my visit in 1971, much of this has become standard in the modern car, without an immense increase of its cost.]

Mercedes was considering other possible, more exotic, solutions to this problem, like gas turbines and Wankel engines, both of which produced less obnoxious air pollution. However, their high costs prevented more serious experimentation. Similarly a totally electrically driven car was ruled out at the time because of development expenses. They had designed a robot car, Professor Förster told us, where the accelerator pedal was varied automatically and which had no gears. It had run without a driver for 80000 km on a special test stand. At the end we visited their splendid Museum of old Mercedes cars, even containing an example of the first model of 1886.

Title 222

Prof. Dr. med. Dres. h.c. Harald zur Hausen, Scientific Member and Chairman of the Board of the German Cancer Research Center.



Title 368

The German Cancer Research Center in Heidelberg after its completion in 1992. Only after the appointment of Dr Harald zur Hausen in 1983 as Head of the Foundation's Board of Directors could the Center reach its potential as a world-renowned institute of excellence under his chairmanship. *Courtesy Press and Publicity Department, DKFZ, Heidelberg.*

When moving from town to town in Germany, we used the highly efficient railway system, which was so fast that their normal stop at a station was only 2 minutes. One of us, Arthur Hazlet from *The Times,* missed getting out in time at one stop, and had to be rescued by the station master at the next town.

In Heidelberg we met Professor K.H. Bauer, who was then 81 years old, and had spent many years planning, pleading for, and finally organising the building of a gigantic Cancer Research Center, equipped with the most modern research instruments. Its cost was estimated then at £ 15 million, considered a very large sum for a single scientific Institute. It even had a small atomic reactor to produce short-lived isotopes for diagnosis and treatment.

When we visited it, it was almost ready to receive its staff of 800 doctors and scientists. The first problem then being investigated was the X-ray contrast medium Thorotrast which, after use, was not completely eliminated from the body, but accumulated in the liver and spleen of patients, causing cancer. It is of course no longer in use. Other priority projects were to identify cancer caused by food and drug additives.

To guide and direct such a large research complex, composed of many individual Institutes, was no easy task and only after the appointment of Professor Harald zur Hausen in the summer of 1983 did it gain its rightful place and began to deserve its world reputation in the field of cancer research. After its existence for 25 years, I published the story of its success. [See Title 368]

After a night at Heidelberg's Five-Star Hotel Europa, we moved on to Bonn [see above] and finally from there, as our last 'big science' star attraction, to the Radiotelescope at Effelsberg in the Eifel. It is completely steerable and at the time was the largest of its kind in the world, with a diameter of 100 m, larger than its British equivalent at Jodrell Bank. We saw it, computer controlled, moving in all directions, while Professor O. Hachenberg, its designer and director, explained its future research projects to us. Four days after our visit it was officially inaugurated.

In conclusion, I can only state that this visit to German science was highly successful and achieved the aims of its organiser. Dr Carsten Salander, then the Science Counsellor at the German Embassy in London and responsible for the choice of projects we saw. My colleagues from the London newspapers were as impressed as I was with the determined efforts of Germany to become again a world power in basic science research, and, through massive financial incentives, well on the way to achieve this aim. By the year 2000 it had been reached.

London's Flood Danger analysed   Title 223

After my visit to the German radiotelescope I went directly to Cologne airport and flew from there via Zurich to Israel, to keep a long-standing appointment with scientists of the Weizmann Institute in Rehovot. It was a scientifically exciting time, although I only succeeded to transmit one, the following story, to the *Daily Telegraph* for publication.

The research work of Professor Ari Ben Menachim of the Weizmann Institute was in my opinion of great value to give London advance warning of flood danger. Using a grant from the United States Air Force, he had developed a mathematical formula which used slight variations of pressure at the bottom of the ocean, to predict the height of the resulting waves at the nearest coast.

The danger of London being disastrously flooded arose from the combination of heavy rains coming down the Thames and at the same time a storm surge in the North Sea coming up the Thames. Their meeting in the estuary would raise the water level considerably, and with the storm surge being stronger than the outflow of the rain water, the only way for the water to go would be up the Thames. Thus it would cause flooding of the London Underground Railway System, a grave potential danger to the Capital and the thousands of Londoners using it daily. All these facts I knew well, having often written about them, and they had been experimentally verified in large-scale model experiments.

When I learnt of Professor Menachim's formula of prediction, I realised its importance for giving London greater warning of impending disaster and considered it vital to transmit it to London. It was published in the *Daily Telegraph* on 14 May 1971. Menachim knew little of London's danger, which I explained to him, as he was concerned about *tsunamis*, the giant waves in the Pacific Ocean caused by underwater earthquakes. Their effects on the shores of Hawaii were equivalent to the storm surges in the North Sea.

The practical engineering was simply to place a car-wheel size pressure sensor at the bottom of the ocean, transmit its movements through a small cable to a buoy on the surface from where the results of any measured movement were broadcast to the warning centre on shore. Menachim developed a Piston Theory that tsunamis were caused by an uplifting of the ocean floor, and he used the ocean bottom devices developed and made by A.van Doorn at the Scripps Institute of Oceanography at La Jolla in California.

London's danger of flooding was removed by building a large barrage across the Thames which had a number of movable gates to let ships pass.

London, in its long history since Roman times, had often been flooded and records exist far back, as for example in the famous *Diary of Samuel Pepys.* On 7 December 1663 he wrote: "There was last night the greatest tide ever remembered, all Whitehall having been drowned."

It was the overtopping of the East Anglia flood defences in November 1897 which finally spurred the British Government into action, and a Royal Commission was set up which reported in 1906 that either the coast tracts were sinking or that the tides had become higher. Then again, during the night of 6-7 January 1928 a particularly high tide overflowed the Embankment in the centre of London and 14 people were drowned.

At last serious research was started, as both Government and the people of London realised the dangers facing them. One of the results was that the 'storm surges' were recognised which occurred when there was high atmospheric pressure to the West of England and low pressure in the East, thus providing a pressure gradient which produced a flow of water into the funnel-shaped North Sea, between Denmark and England. A second discovery was the gradual downward tilting of the southern part of England, due to the rising of Scotland, as the result of the effects of the end of the last ice age.This amounted to about 2.5 cm per century, a quarter of a meter since the time of Roman occupation of the British Isles.

Together with the highest tide ever recorded in London, 2 meters above the predicted level, the final disaster occurred on 31 January 1953 with over 150 people drowned. Only in 1965 a study started of a Barrage across the Thames, designed to safeguard once and for all the Capital city of England. The 1953 flood caused the breaching of many dykes in the Netherlands, where the death toll was 1853 people. There, as a result of this tragedy, the great DELTA Plan was conceived andcarried out in the following decades. [See next page and Title 365]

In London, the great 500 m long Thames Flood Barrier was built and completed in 1982 with its seven huge gates, normally removed to let big ships pass upstream to the Docks. However, by 1982, this magnificent engineering achievement had become quite unnessary, as the great revolution of container transport from 1960 onwards, had occurred. It made Tilbury, far downstream from the Barrage, into London's major container port by 1965, and no large ships were any longer moving upstream to the Docks in central London. A simple dam, much cheaper, with suitable locks for small ships, would have had the same result of preventing high tides from reaching Central London. What an example of administrative delay and lack of interdisciplinary planning!

The storm surge which caused the overflow of the Thames in England, on 31 January 1953, was responsible for a major catastrophe in Holland with 1853 deaths, with 1200 km of dykes destroyed, 500000 acres of land flooded and 72000 people made homeless. Disasters were nothing new to the Dutch, with terrible floods in 1574, 1775, 1808, 1894; the worst of these was the disastrous Saint Elizabeth Flood of 1421 which drowned more than 10000 people.

Never again, was the resolve of the Dutch Government, and its proposal to provide a storm surge barrier across the whole Rhine, Meuse and Eastern Scheldt Estuaries was accepted by Parliament on 23 June 1976 and passed into law: The Delta Plan. It was completed on 4 October 1986, when Queen Beatrix opened the barrier across the Eastern Scheldt. During these 10 years Europe's greatest interdisciplinary macro-engineering project demanded many new technologies, as for example the construction of two special ships to lift 62 giant concrete piers, each weighing 18000 tons, and deposit them in precise positions on mattresses in the river bed.

I was naturally most interested in, and considered it my duty to report on, the Delta Plan, as during the same time the Barrier across the Thames was much discussed in England and finally completed in 1982. My first article on the Delta Plan was published in the *Weekend Telegraph* of 18 January 1965, and it could reproduced three large colour photographs, two coloured maps and 1.06 column meter of text. I often visited the building sites of the dams in Holland and got to know the Chief Engineers H.A. Ferguson and his successor H. Engel. Later, as Editor of *Interdisciplinary Science Reviews* both contributed extensive reviews to my Journal [*I S R* Vol. 1, p. 247 (1976) and *I S R* Vol. 14, p. 29 (1989)] describing in considerable detail the macro-engineering tasks and the ecological consequences of the Delta Plan. [See Title 365]

The Delta Plan had a threefold objective, to provide an impenetrable barrier against storm surges, to construct a highway across the three major dams to open up the district to trade and commerce, and thirdly to provide a fresh-water reservoir for agriculture and industry. Ecological pressure, however, demanded the free flow of sea water into, and out of, the Eastern Scheldt area to preserve its fishing industry, and hence the dam across it to guard against the storm tides needed sluice gates of gigantic size. This was achieved by 62 inlets across the 3 km length of the dam, the sluice gates being suspended from huge piers 45 m apart, built at the rate of one every two weeks. The special ship *Ostrea* [Oyster] lifted these piers from the nearby dry construction site and placed them in their centimeter precise position on the river bed. This magnificent macro-engineering feat alone deserved, according to my judgment, the greatest praise I could give.

My first encounter with the city of Venice was not that of a gaping tourist. I was amazed to see the long snakes of Japanese tourists obediently following their guide holding up a coloured piece of cloth, a tiny umbrella or a large flower. This I had never seen before in London, where Japanese tourists often appeared singly in Oxford Street or at other sights. My first visit to Venice was a truly scientific one, as at the end of October 1971, a group of London Science Correspondents, including myself, received an invitation from IBM to visit Venice, in order to see their Computer Laboratory at Papadopoli. There an IBM team had, during the last four years, worked out mathematical models to predict the vital water flow through the lagoons and thus calculate accurately in advance the height of any flood threatening the ancient city.

> For a long time four major dangers have threatened Venice. Subsidence, due to the lowering of the water table in the whole of the Po Valley. This had been caused during the last 50 years, by drilling 50000 Artesian wells to provide water for the Population and for Industry. This effect is irreversible.
>
> Storm surges in the Adriatic Sea and the resulting high tides. These could be stopped by building a barrage with floodgates between the outlying islands, one of which is the famous Lido. This is one solution.
>
> The population increase which has brought with it severe pollution of the canals by sewage and domestic effluents. At the time of my visit I was appalled by the strong smell of hydrogen sulphide emanating from the smaller canals, indicating that there was no longer any oxygen in the water and all aquatic life had been killed.
>
> Air pollution from the exhaust fumes of the motor-boats, damaging the stone work of the buildings up to a height of 4 meters above sea level.

These facts were given to our group during extensive briefings organised by IBM and by Professor Francesco Valcanover, the Superintendent of Fine Arts of Venice. We were also informed that a foreign loan of £ 160 million had been approved by the Cabinet of the Italian Government, and it was hoped that close collaboration between the Municipal and Regional Authorities as well as the Italian Government would now lead to a rapid progress in the preservation of Venice. However, none of our group was convinced of this, and as it turned out, political and financial squabbles have delayed and hindered the preservation, far more than a lack of scientific and engineering solutions. [See also "The Flood Problem of Venice" *Interdisciplinary Science Reviews,* Vol. 6, No. 1, p. 57, 1981]

In 1971 I wrote many exciting daily science reports, most of which were published in the *Daily Telegraph.* Below is a list of some of these and as I stated before, any bona fide historical researcher who would like to have a copy of either the published report, or my original hand-written notes on the subject, may ask me for a copy and, if possible, I shall send it. The fact that they are not included in full here is simply due to lack of space.(For previous Routine Science see Titles 95, 115, 139, 156, and 213)

WORLD WIDE TELEPHONE DIALLING
STAR FISH STUDY TO SAVE CORALS
SAN ANDREAS FAULT SLIPS
ROYAL COMMISSION ON POLLUTION
FIREBALL INFORMATION SOUGHT

VENUS RADIO ASTRONOMY
BLACK BOX WATCHDOG FOR ELDERLY
SCIENTISTS AIM TO PROTECT SEA TURTLES
HAEMOGLOBIN – THE BREATHING MOLECULE
COSMIC RAY FLASHES BEFORE THE EYES

TRANS-ALASKA PIPELINE
COMPUTER CONTROL FOR AIRCRAFT
RUSSIAN SPACE LAB TO COMMEMORATE 10 YEARS OF SPACE
EMPEROR HIROHITO ELECTED F R S
ANTI-FIRE CHEMICAL

TO-MORROW'S WORLD TELEVISION
LORD SHACKLETON PRESIDENT OF R.G. S [ARM SKETCH]
MAN BEATS MACHINE ON THE MOON
SPIDERS AS TECHNICIANS
RUTHERFORD CENTENARY

ICE CLUE IN STONEHENGE MYSTERY
COAL FACE REVOLUTION
DUTCH ELM DISEASE
CARBON FIBRE OARS FOR LIGHTER ROWING
MARINER 9 WINS MARS RACE

KALINGA PRIZE FOR DR MARGARET MEAD
DOCTORS WANTED IN ANTARCTIC
CONTROL OF SCIENCE WANTED BY LORD ROTHSCHILD

French Penal Colony in Guyana—My Account Title 228

[The Editor of the DAILY TELEGRAPH refused to publish this feature telling me "This is too grim for our English readers at the breakfast table". See also Title 144. The text below is exactly what I cabled to London at the time and has never been published before.]

None of us, a group of 40 European science writers, knew the special significance of *'kilomètre 24'* as we were driven in a bus in November 1971 from Cayenne, the Capital of French Guyana, to Kourou, the launch site of a European space rocket. [See below] This coastal road of poor surface, with the magnificent title *'Route Nationale No. 1'* runs between two vertical walls of dense tropical jungle, and 24 km from Cayenne, crosses a deep swamp with mangrove trees on both sides.

There, we were told by our French guide that more than 700 convicts paid with their lives to build the road across the swamp, dying from leprosy, yellow fever, dysentery and malaria. But then the lives of convicts were cheap. Of the 70000 men sent to the Penal Settlements in French Guyana between 1854 and 1954, 50000 died, mostly from diseases, malnutrition, ill-treatment and murder by their fellow convicts.

This 'Belsen of France', included the infamous 'Devil's Island' where the French Army Captain Alfred Dreyfus was incarcerated from 1894 to 1899. He had been falsely accused of treason, and being Jewish, he and his family had the greatest difficulties to clear his reputation and have him reinstated in the Army. Finally they succeeded and he was promoted to the rank of Major.

When in 1971 we visited Devil's Island, officially called Isle Royale, it was housing a tracking camera for the Kourou Space Centre. Also the dreaded solitary confinement cells which I saw and sketched, were still there as incontrovertible evidence. Each cell was 2 m long, 1 m wide and 3 m high with a 15 cm hole in the ceiling, the only opening for light and air. During the 17 years since the French closed the Penal Settlement, jungle roots and tree branches had entered the cells where the walls had disintegrated. I had to use a torch at noon to look inside. These cells would make an even grimmer tourist attraction than the rather cool and spacious dungeons of the Doge's Palace in Venice, visited by thousands of morbid sightseers each year.

But then the Isle Royale is 10000 km from London and far off the beaten tourist track. At the time I went, an eccentric English woman painter was living alone on the Island, who liked the solitude, but missed English cheeses, bacon, and a boat. Like many French people to whom I talked about the Penal Settlements, she did not want to believe the atrocities committed in the name of French justice.

See Watercolour Title 228, inside Front Cover

Just as the French were incredulous about their Penal Colony in French Guyana, so were the Germans after World War II when the Concentration Camps were discovered. No-one can tell, if all the horrors described in the then popular novel *Papillon,* happened to the same person or were a collective experience of many unfortunate convicts. Yet, I read three other books about French Penal Colonies and the same stories recurred, as for example the self-inflicted mutilations by poisonously infected and broken knee caps, to avoid being sent to the extermination camp of *'kilomètre 24'.*

The theoretical justification for a penal colony—also heard in England, America and elsewhere during the 17th and 18th centuries—that a criminal benefits from working on the land, and that the land benefits from convict labour, can today be considered as an excuse for 'man's inhumanity to man'.

The deep shadow which the century of Penal Deportation had cast on French Guyana had hardly began to lift, when our group of science writers visited it in 1971. The expression of 'underdeveloped country' must have been especially coined for it. The country, roughly twice the area of Wales, has a population of about 38000 of which 24000 live in the Capital Cayenne. They are mostly the descendants of liberated slaves, a few native Indians from the interior jungle, the French Administration officials, and most recently, about 4000 German, Dutch and English engineers and their families, who work for ESA, the European Space Agency, at the Rocket Launch Station of Kourou.

The site of Kourou was chosen because it is 5° north of the equator and rockets can be launched from it in an easterly direction over the Atlantic Ocean, thus benefiting from the speed of the Earth's rotation. It is also well sheltered from cyclones. A large capital investment from France was necessary to build it, improving roads, bridges, a power station, a fresh water pumping unit and the essential clean facilities for the final preparation of satellites.

Yet in spite of ample rainfall, 4.5m a year, of the almost complete elimination of tropical diseases through the work of the local Institut Pasteur, but neither agriculture, forestry nor mining, the three natural resources of the country, were being developed when I was there. Most food was imported from France. As a final historical note, one might remember that Sir Francis Raleigh described the country in 1595 as *Eldorado,* the fabulous land of gold.

[This is a transcript of my handwritten notes, transmitted for publication from Cayenne to London on 8 November 1971, to the Daily Telegraph, but never printed. Here I have made only minor stylistic and editorial changes.]

When I left London on 1 November 1971 to fly to Paris and on to Cayenne, the Capital of French Guyana, I knew my report would not make the Front Page. I had been invited by ELDO, the European Launcher Development Organisation, to watch the launch of their Europa F 11 rocket from the Kourou Space Centre on the equator in French Guyana. I accepted the invitation, although I knew that the launch of a small unmanned rocket would pale into insignificance compared to the Apollo 11 flight to the Moon. Apollo 15, launched in July 1971, was still fresh in my mind with its first use of the lunar rover [see Title 218].

Our group of 40 European science writers met in Paris, and we boarded a Boeing 747 for the transatlantic flight. At that time, this type of aircraft was still very new and I was greatly impressed with its size. As usual, I read some science fiction space stories during the long hours and wondered if I should ever see the day when an equally large space rocket would leave the Earth and take me to a distant planet—perhaps my grandchildren might enjoy it as much as I enjoyed the comfort and luxury of the Boeing 747.

ELDO had a long prehistory and was not known for its successes. It was in 1955 that Britain developed its Blue Streak medium range missile, the engine being built under an American licence by Rolls-Royce. However, only five years later, in 1960, the British Government suspended this programme because of costs. But in 1961 a European Space Conference decided to use the British Blue Streak rocket as the first stage of a new launch vehicle, to be called Europa, with the French Coralie rocket for the second stage and a German rocket for the third stage. ELDO itself was formally constituted in 1964, but none of its Europa rockets flew perfectly, one of the three stages always failed, as I was soon to see for myself.

When we arrived at Kourou, all was going well with the countdown. Although Britain had left ELDO in 1968 and had become only a non-paying member, there were about 70 British engineers and scientists working at Kourou. Europa F 11 flew for less than one minute, and as we saw a few days later on a dramatic film, recorded through a 4 m long lens from the Isle Royale, 16 km away, Blue Streak had exploded and led to a failure of the mission to place a satellite into orbit. This failure had as a consequence that a year later the Europa project was cancelled and ELDO itself became in 1974 an integral part of the new ESA, the European Space Agency.

As there was no return flight to Paris for several days, our group of science writers decided to charter a boat and visit the Isle Royale, the former French Penal Settlement. [See Title 228]

See Watercolour Title 230, inside Front Cover

Science fights Terrorism — Title 231

During 1971 the fight between the IRA (Irish Independent Army) and the British Army was never far from the headlines of the newspapers, and I was not surprised when I was asked by Lord Hartwell, the owner of the *Daily Telegraph*, to find out what science could do to help in the conflict. I flew to Belfast and my first sight was a large fire in the centre of the town, caused by terrorist activities.

At the Army Headquarters in Lisburn, Northern Ireland, I was able to talk to two Ministry of Defence scientists, permanently attached to the Army, who gave me some information, but I was told that I could not publish their names. They were optimistic that new equipment, constantly being researched at the laboratories of the Ministry, would help to overcome the IRA. One of them told me: "Our highly sophisticated scientific backing is constantly forcing the terrorists into new areas where they are not well equipped. This leads them to overplay their hand—which is exactly what we want."

One of the latest techniques at the time of my visit in December 1971 was to be the use of radio waves to explode bombs with electric detonators, hidden in cars or on terrorists themselves. (I was not told the frequency which was to be employed). Another useful device, already in routine use, was a highly sensitive metal detector which detected even a single round of ammunition hidden on a person.

One of the most often employed weapon was the rubber bullet, designed and developed at a research establishment of the Ministry of Defence. The Army had stated its requirement as something less lethal than a rifle bullet, but more harmful than CS gas. (CS gas was also developed in Britain for riot control, having originally been discovered in America—see Title 160)

Vital in the fight against bombs is the knowledge where they are placed, in what container and how they are detonated. Here many scientific disciplines were called in to help, as for example cryogenics, immersing the bomb container in liquid nitrogen at a temperature of -196 °C to solidify any oil and thus stop any mechanical detonation device. Radiography and x-rays have also been used for the detection of hidden bombs.

The age-old problem of detecting a hidden sniper at night has been solved by using infrared techniques in 'night vision' devices. Personal protection in cars was much advanced by using see-through plastics produced from glass fibres and polycarbonate mixtures. "All Government science laboratories are at our disposal and often industry has given us valuable knowledge and advice, at their own expense" concluded a bomb disposal officer who talked to me.

Chemophobia Title 232

It must have been in 1972 that I first noticed an emphasis in the *Daily Telegraph* to give great space to my reports on 'bad science'. Stories about pollution, possibly poisonous chemicals on beaches and similar accidents were given more prominence than beneficial aspects of science. I could not discover if this was a reflection of a personal prejudice of any of the Editors or a reflection in their minds of what they perceived to be the attitude of the general public. [See also 'anti-science' Title 204]

So for example a few drums were washed ashore on to beaches in Cornwall in the middle of January 1972, and I was informed that they contained toluene di-iso-cyanate, a chemical widely used as a raw material for the synthesis of plastic foam. This was of course a dangerous molecule, because it contained the cyanate radical, and if brought into contact with acids or heated, would give off the deadly hydrocyanic acid gas. But was this likely? Were the removal services, the Royal Naval Bomb Disposal Unit sufficiently aware of the chemical consequence, or did they contact the manufacturers, the Union Carbide Company of America (of Bhopal disgrace), to inform themselves about any likely or unlikely dangers? The headlines for my small comment, 9 column centimeters, read "Powerful Poison—World War I Use"!

I returned to this very same incident a few weeks later in my *"Science Column"* and began by pointing out that this proved how unprepared England was to deal with any real chemical emergency, like Bhopal, for example. [See "Lesson of Bhopal" *Interdisciplinary Science Reviews,* Vol. 10, No. 3, p. 193, 1985, and Title 343 in this book]. I was able in this longer report to give more details and explained that the contents of the drums was quite unknown for several days, and only when the manifest of the sunken ship which lost these drums was published, it became clear that some drums contained ethyl acetate and other cyanate compounds. It was entirely due to luck that the Bomb Disposal Unit blew up the ethyl acetate drums and not the cyanate ones.

I blamed in my article both the Ministry of the Environment and the British chemical industry for this lack of knowledge of chemistry. The Ministry could have had chemical experts and decontamination teams on the beach within a few hours, had they been informed. The chemical industry should have an expert bureau available for 24-hour information as an emergency service to advise or guide experts, if they could not themselves immediately help. In the absence of such a bureau, I warned that the reputation of chemistry would further deteriorate than it had done during the last few decades chemistry loose its good name.

It was not until June 1996 that I wrote a full analysis of the fear of chemistry, *Stop Chemophobia* and published it in *Interdisciplinary Science Reviews* as my last contribution before my retirement as Editor. [See Titles 405-407]

See Watercolour Title 232, inside Front Cover

The most important conference ever planned by the United Nations to consider the Human Environment, with the well-chosen title: 'Only one Earth' was called for early June 1972 to assemble in Stockholm. It was the brainchild of the Canadian self-made millionaire Maurice Strong who not only persuaded the Governments of many nations to participate, but also organised the details. He was able to do the same 20 years later, in Rio de Janeiro Conference in 1992. [See Title 382] He acted as the Secretary-General of both Conferences, a unique achievement. The next congress is planned for 2012.

It was a mammoth conference, 122 countries of the 145 invited attended at Ambassadorial level. 1200 journalists reported the proceedings, and it was estimated that the costs were in excess of £ 11 million pound sterling. In addition to the official Conference, thousands of hippies came to Stockholm to state their own case for a better environment and to attack the War in Vietnam as "Man's most shameful murder of the Environment", as one put it to me.

Even before the Conference opened officially on 5 June, controversy had arisen about the participation of East Germany, and the British and French Governments tried to ban Concorde's supersonic noise pollution from discussion in Stockholm. The Soviet Union, Poland and Czechoslovakia refused their invitations as long as East Germany, which was not a member of the United Nations, was not also represented. It proved a good excuse for them to avoid giving an account of their own heavy pollution. No one expected a harmonious Conference, but it was hoped that factual and scientific differences were to be discussed and that political opinions would be excluded.

There was no dearth of documents before the Opening of the Conference. The proposed recommendations covered 600 pages, distilled from 77 national reports which covered 12000 pages, or 6 million words. No delegate, no journalist could possibly read more than a small fraction of this material, so laboriously prepared, translated into the official languages of the UN and duplicated in hundreds of copies.

Accommodation for all was a further problem, and if not reserved well in advance, simply meant to stay 50 km outside Stockholm and commute daily. Even to summarise all the lofty aims of the Conference would be impossible, I reported. The major one was 'The Declaration on the Human Environment' stating that countries were responsible for the pollution they caused beyond their frontiers. 'Global Monitoring of Pollution', the Earth Watch System, was another aim, considered by many scientists the easiest to achieve.

This Conference in 1972 was headline news, and reported world-wide by all who were able to get their views into print, regardless whether they were against pollution and for the preservation of the human environment, or if they considered it all 'left-wing propaganda' and that nothing needed to be altered. I belonged to the first category and I filed at least one report from Stockholm every day.

I give here only the titles of my published reports and use the same measure of 'column-centimeters' C-C, as I have done before for Apollo 9 and 11.

DATE	*HEADLINE*	*C–C*
May 31	Russia Likely to boycott UN Conference	8
June 4	China at Doom-Watch Talks	30
5	Nations talk on Pollution	23
6	Britain to back World Survey on Pollution	23
7	Conference Attack on Pollution by Supersonic Jets	56
8	Concorde Tests to be published	31
9	Britain seeks UN Support to stop Ocean dumping	32
—	London War on Air Pollution 'Example to the World' (1956 Legislation banning coal fires in domestic grates, see Title 270)	37
—	China attempts to reshape Pollution Declaration	43
10	Britain wins Fight for Talks to ban Ocean dumping	34
—	Children's Pollution Test on TV	14
19	Measuring Pollution—Earth Watch	10

Considering the above titles of my published reports, it would seem that the Conference I attended in Stockholm was solely concerned with Britain, its defence of 'non-polluting' supersonic flights and its fight against pollution by ocean dumping. The Conference dealt of course with many other, international, subjects to preserve the Human Environment, which I duly reported to the *Daily Telegraph*.

But the policy of all newspapers is that the Night Editors select from the great abundance of material submitted for publication only such items for printing, which support their newspaper's political views. No reporter, whatever his special field, can win against the all-powerful decisions taken at night in Fleet Street. (In 1972, the *Daily Telegraph* still had its printing works and its Editorial Offices in Fleet Street.)

Apart from Ministers, Ambassadors, Civil Service Delegates, the Directors General of WHO and FAO, there was also at the Conference the unexpected visit of Mrs Shirley Temple, (the child-star of the cinema) as special UN Observer, and Barbara Ward, the famous authoress. It was a free-for-all!

With this title I wrote a feature article on 11 March 1972, about one month before the launch of Apollo 16, and nearly three years after the first men set foot on our nearest neighbour in space. My opening sentence read: "It cost American scientists a great deal of money and worry to learn what poets and lovers had known for centuries. *The Moon is a fickle Mistress.*"

I continued by analysing the cost of Apollo, and by 1972 a total of £1200 million pound sterling had been spent, of which NASA's annual budget was roughly £ 2000 million, a sum equivalent to what American women spent each year cosmetics on nail varnish, face powder and lipsticks. At the same time, the American defence budget, including the Vietnam War, was in the order of £33500 million – 28 times as much as space exploration by a single Apollo flight.

It was more soothing, I thought, to outline briefly man's and woman's waxing and waning interest in the Moon during the last three centuries. Before 1610, the Moon was the guide for the traveller and for those of unsound mind, still called 'lunatics' today. Then in 1610 Galileo pointed his first telescope at the Moon, and scientific interest took over. Telescopic exploration from Earth gave astronomers, or more precisely selenographers, ever more precise maps of the Moon, its Marias, Rills and Craters.

But all was barren on the Moon, there was no sign of any life past or present, which had so often been postulated in imaginary literature. Interest waned, although Arthur C. Clarke in his great film *2001* showed a monument on the Moon left there by another, an extra-terrestrial civilisation. After Apollo 15, American astronauts had brought back to Earth 200 kg of Moon rocks and many new facts emerged. So for example, the age of the Moon could be fixed as 4700 million years, compared to the Earth's of 3500 million years. It could be concluded that Earth and Moon were of about the same age, as the oldest rocks on Earth had been fused, molten and lost.

Another discovery was that under the five great nearside Marias on the Moon, Imbrium, Serenitatis, Crisium, Nectaris and Humorium, great chunks of a heavy material were hidden. This was found by unmanned satellites orbiting the Moon, deviating from their precisely calculated paths, caused by higher gravitational attraction over the Marias. By 1972 much scientific material had been left behind on the Moon, like Surveyor and Lunar Ascent Modules as well as their return-launchers of the Apollo flights. I concluded my article with a suggestion that future Moon explorer's of the next centuries would look at these with the same awe which we reserve for ancient steam engines. They will always be evidence and testimony of the immense patience, consummate skill and astonishing ingenuity of man during the 20th Century.

Although I was not in Houston for this flight, I fully commented on it. I was able to watch it almost from beginning to end thanks to the excellent facilities of the BBC Television studios in White City, London. It was a great privilege to have been invited to watch the BBC screens, as they had continuous and direct transmission of Apollo 16 events from NASA in the USA.

Apollo 16 was launched on 16 April 1972 and its flight duration, until splash down, was 265 hours and 51 minutes. During three excursions with their Rover vehicle, the astronauts covered a total distance of 27 km and brought back to Earth a total of 97 kg of Moon material. So far the official record.

As it had been announced by the US Congress that Apollo 16 and 17 would be the last missions to the Moon, scientists were most anxious to get the maximum of information through special instruments to be left on the Moon. Apollo 16 was therefore carrying more of these than any previous flight. I was able to publish a lengthy article, 74 column-centimeters, the day after the launch, describing in detail the instruments and the expected results.

One of these was a lunar magnetometer, electrically powered by a radium isotope generator, which also provided heat for the instrument during the lunar night when the temperatures drops to -207 °C. It was only part of the automatic laboratory, called Apollo Lunar Surface Experimental Package, ALSEP. It also contained an automatic astronomical observatory, the first ever to be set up on the Moon. Using ultra-violet light, it was designed to record clouds of hydrogen. Furthermore, a cosmic ray detector was included in this flight, bolted to the outside of the Lunar Landing Module, and returned to Earth with the astronauts.

Later, when summing up Apollo 16, I wrote: "Brilliantly successful scientifically, but disappointing from an engineering and operational point of view". A high reading of magnetic activity, 10 times higher than any previously recorded, was one of the most significant discoveries. Among the more than usual mechanical faults of the flight were failure of the back-up gyroscope, even before the launch; the failure of one of the docking latches linking the two spacecraft; the landing radar to stee the Landing Craft shortly before touch-down on the Descartes area; and the mos serious the failure of the main engine, while the astronauts were behind the Moon. Had it been impossible to correct this break-down, the astronauts would have been condemned to orbit the Moon indefinitely. In spite of all these failures, Apollo 16 splashed down successfully on 27 April at 20 hours GMT and 45.7 minutes, as I noted. (Note the decimal number for minutes an improvement suggested by French scientists at the Revolution of 1789, when a decimal clock was advocated).

Scientific Medals exhibited in Washington — Title 237

I have already (see Titles 74 and 75) given a brief account of collecting scientific medals, writing about them and the various events at which I was invited to show them. Here I want to record their very first exhibition, when the National Academy of Sciences in Washington DC, was honouring me with an invitation by its President Dr Philip Handler, to present a selection of medals during their Annual Meeting. The exhibition was longer than the Academy's Assembly and was open to the public from 10 April to 31 May 1972.

By that time my collection must have consisted of about 1000 medals, and I had to make a choice of 250, to keep it within reasonable limits, yet present a representative survey of the many scientific disciplines and the great variety of materials of the medals. The first problem that arose in the planning of an exhibition, thousands of kilometers away from their normal home, my flat in London, was of course their transportation. As most of them were struck in metal, and thus very heavy in bulk, suitable wooden boxes had to be procured, not very easy, but I was lucky and found ten of them.

The second problem was to produce display labels for each item. This demanded a special large type face and a solid card, so that they blended harmoniously with the display and were easily legible. These cards were most kindly and most beautifully typed by Helen Rogers, a very good friend in London, weeks before dispatch. Then the medals had to be packed in the boxes, and there chemically inert plastic foam proved ideal.

But these were the preliminaries. The boxes had to be sent from London to Washington and returned, without the cumbersome Customs formalities which would have arisen if detailed contents lists of each box and their values had to be presented, if a commercial shipper would have had to be employed. Fortunately another good friend was able to help, Dr Alan Melcher, the Scientific Counsellor at the American Embassy in London. He used the diplomatic pouch, and this proved the ideal solution, free of any cost to the Academy and myself.

In Washington, the Smithsonian Institution lent the Academy suitable display cabinets, and Succie Lewis, the Head of Public Relations of the Academy, sent out prestigious invitations for the Opening and produced an excellent Press Release. It all proved a great success, many distinguished visitors came on the day to see what was described as 'a unique collection of international scientific medals'. Press notices appeared in the *Washington Post* and the *New York Times*, and a delightful party was the final highlight of an unforgettable day for me. Dr Handler was very appreciative of the display and thanked not only me but also my friends, without whom it could never have happened.

The Bizarre Cargo Cult Title 238

The Cargo Cult in New Guinea is probably the strangest of all effects which science and technology have bestowed on any part of humanity. During a visit to the Headquarters of the National Geographic Society in Washington in 1972, I obtained the latest information of, and the most recent aspects about, this bizarre Cult. It started in 1871, when a Russian explorer, Baron Nikolai Maclay landed in New Guinea and made friends with the local natives by the distribution of axes, glass trinkets and cloth as gifts. From this simple friendly act, grew the belief that ships, like the Baron's, would continue to provide gifts, if the correct rituals were performed by the native receivers of the presents.

The latest ritual was to erect a monument to the 'donors' in Canberra, Australia, costing £ 8000 pound sterling, from where, at the time, New Guinea was administered. The adherents of the Cult hoped to invite Queen Elizabeth and the Pope to the inauguration of the monument and thus to start again the free flow of foreign gifts to them which had of course ceased. The foreign missionaries which followed the Baron were thought to teach the rituals to provide the gifts, but had failed. Then the Invasion by Japanese troops during World War II disturbed all hope as the missionaries were driven out, and this was considered as punishment for not performing the correct rites.

But Lo and Behold, when after the War American, British and Dutch armies returned to New Guinea, a new flow of magnificent gifts arrived by air. Even natives who had seen in Australia the manufacture of 'gifts' in factories, could not believe that the massive flow of military equipment which arrived in the Islands, the seemingly unlimited supplies of arms and food, could have been produced by simple human beings, without the support of magic.

When the War had come to an end and the jungle had once again overgrown the airstrips, the adherents of the Cult hacked out new landing facilities and even built a mock aircraft, but it did not fill up with gifts. After each failure, the natives returned to their farm plots and their jobs, but their faith remained unshaken, and new forms of the Cult arose.

So for example two survey markers, left behind by one army or another, were pulled up and dragged up to the top of Mount Tulu. They were thought to be 'corks' bottling up the flow of riches—but once again they were disappointed as 4000 of them danced around the markers on top of the mountain.

The Cargo Cult, originating from a simple friendly act, enhanced by science and technology, appears to me as one of the problems which will remain unsolved until widespread education can explain modern society and its acts, to the adherents of the Cargo Cult. Is this a unique (?) negative result of the Scientific Temper?

Is Industry inevitably engaged in Pollution? Title 239

This was the question of an Editorial in the *Daily Telegraph* on 10 February 1972, which was assuredly not written by me. It referred to the lead and zinc pollution of the Avonmouth Smelter, near Bristol, owned by the Rio Tinto Company. The discovery of the heavy pollution in the surrounding area of the smelter, the remedial action by the Company, and the reaction by the relevant Trade Unions, all provided front page stories for me and finally led to the sentence in the Editorial quoted above.

The smelter, officially opened by the British Prime Minister, Mr Harold Wilson on 10 May 1986, was widely hailed as an outstanding example of the "white-hot technological revolution" which he had hoped to originate on his election. The plant cost £ 14 million pound sterling and had more than its usual share of commissioning troubles. Mr David Morgan, at one stage its General Manager, told me in July 1972 "It should have had another £2 million spent on it, because the equipment was unreliable and inefficient."

When less than four years after commissioning, workmen reported sick from lead and zinc poisoning, it was considered one more accusation against chemical industry and was a further instance which led to general chemophobia, the fear of all chemistry, which I discussed on Title 232 and on Titles 405-407. I went to interview the scientists at Bristol University who had tested leaves in the neighbourhood of the plant and had found 7000 parts per million of zinc on elm trees. This I reported in a 60 column-centimeter story on the front page of the newspaper, and it led to the appointment of an official enquiry by the Department of the Employment.

The Company shut down the plant and announced that this was the 'official annual maintenance'. However, the workmen engaged in the clean-up demanded extra pay for the work, and when this was refused, went on official strike. Thus the plant remained shut down until the end of April, when it was officially announced that the "fall-out was low during the closure of the plant" (sic).

However, the District Officer of the Trade and General Workers Union told me that he wanted permanent monitoring and said "The present improvement may be all right, for the first week, or the first month, or even for three months, but we want our people permanently and medically monitored".

These events proved to me that chemophobia was justified under scientifically documented pollution, but that hysteria about all chemistry was of course totally wrong. It also showed that proper Trade Union concern about the health of workmen has an important role to play in Industry, if the Trade Unions employ scientific advisers, as they did in this case.

Heart pacemakers are miniature electronic devices which rhythmically stimulate the heart of patients suffering from certain heart irregularities, like 'heart-block'. The pacemaker takes over the natural regulator of the heartbeat, it is permanently implanted, but it must rely on a source of electricity, like a nickel-cadmium chemical battery, to be replaced about every two years, or in the case of a nuclear power source, every 10 years. It was towards the end of 1972 that the first nuclear pacemakers were ready for general implantation. My article "Help for the tired Heart" was published 6 November 1972 in the *Daily Telegraph* and was 38 column-centimeters long.

I had visited the Weizmann Institute in Rehovot, Israel, in October and learnt of another ingenious method to overcome the two-yearly replacement of the pacemaker. "Let us recharge the battery from the outside" was the ambition of Professor Frey and Dr Fischler of the Institute. By the time I saw them they had succeeded. A small ring, carrying the recharging current is fixed over the area of the pacemaker for one night, every three to six months, and this proved successful with dogs when I saw them. They proudly added that an American electronic company had already acquired a world-wide option on their invention.

Scientifically most interesting is of course a nuclear energy source for pacemakers, 180 milligramme of plutonium 238, whose heat-producing radioactive decay is converted by a special thermoelectric module into electricity. Only after 89 years will its output be reduced to one-half. The safety aspect of permanently implanting into a human body the radio-active plutonium source was a consideration uppermost in the minds of all workers in this field. First of all the plutonium is enclosed in a special steel capsule, and its resistance was explained to me by Earl Bakken, the President of the American Medtronic Company, when he visited London at that time. His pacemakers use the French model, Alcatel.

During an interview he told me: "The nuclear pacemakers which we manufacture can withstand gunshot wounds, they are unaffected by the 1300 °C temperatures of the crematorium fire, and they can be run over by a train". The same is true for the British nuclear pacemakers, first implanted in a patient in July 1970 and thus antedating all others.

These were developed in two research laboratories of the UK Atomic Energy Authority and manufactured at the rate of five a month by the American General Atomic Company of San Diego. The British Health Department ordered at that time 1000 pacemakers, while the *New Scientist* reported on 12 December 1972 that a Berlin Hospital had already implanted 100 nuclear pacemakers.

I have already discussed Disasters on Titles 81 and 82, and in October 1972 statistics became available which justified (if that should be necessary) my concern about the shocking state of affairs world-wide. The US State Department published its 11th Annual Report on *Disaster Emergency Relief* covering the period 1 July 1970 to 30 June 1971.

During that period, it was estimated, that more than 500 000 people had been killed globally and more than 68 million had been affected by natural disasters and civil war. But funds raised during those months for disaster relief had also reached an all-time high, almost £ 500 million pounds sterling. One of the most obvious reasons for the increase of disasters was the growing world population, not much less than 100 million people each year. A second reason was that more dangerous regions of the planet, like coastal areas, were being built-up and densely populated.

Had the number of natural disasters, like cyclones, floods and earthquakes, increased in historical times? This question, so often asked by scientists and decision-makers alike, has never been answered satisfactorily, simply because no accurate records were ever kept until very recent times. The US State Department began to record such data in 1960 and found 1970-1971 to be the worst so far measured. I discovered the best statistical analysis of disasters during the last 50 and 100 years in *Topics 2000—Natural Catastrophies—The current Position,* published 1999 by the Munich Re Group, 80802 Munich [Avaiable at no charge].

There certainly was no doubt that Civil Strife had grown worse in the years after the end of World War II in 1945. Much of this increase was due to the end of the Colonial Period in Africa and elsewhere and that local rulers, often with dictatorial powers, fought their opponents in brutal and primitive battles, without consideration for civilian casualties, whether men, women or children. The existence of child-soldiers, a crime against humanity novelty, also contributed to the ever—increasing number of victims.

The only means at my disposal to rectify the infamous situation of disaster prevention and disaster relief, whether by better prediction of natural ones, or by rehearsal of rescue for man-made disasters, was to lecture and write about this subject. During my 20 years as Editor of *Interdisciplinary Science Review* I wrote four Editorials, 1977 Vol. 2 No. 1, 1980 Vol. 5 No. 2, 1984 Vol. 9 No. 3, and 1991 Vol. 16 No. 3. Nothing seemed to change, although the United Nations set up a small office in Geneva. I concluded that "Disasters had no constituency which would be financially interested in ameliorating the situation by systematic world wide information or by special research projects." and "Disaster research is asking scientific questions about Acts of God" I wrote in 1984. But no one has yet dared to do so!

Apollo 17 was to be the last Moon exploration of the century, and no one knew when man would again walk proudly on his next neighbour in space. Much was yet to be explored and to be learnt, but the American public had lost interest in space and the US Congress therefore—probably rightly—concluded that of further Apollo Missions should be cancelled. Why the American public had lost interest was hotly debated, in view of the country's historical zeal to explore the 'endless frontier' of the West. In my opinion, the reason was that the American space industry had failed to provide sufficient information for the public about the coming of the 'New Renaissance' which space exploration, and its resulting social changes might bring to the world.

Hope that later generations would again start, where Apollo 17 had left off, was beautifully and correctly explained by Lord Shackleton, at the time the President of the Royal Geographical Society of London and the son of the famous Antarctic explorer, Sir Ernest Shackleton who in vain had tried to reach the South Pole in 1908. Lord Shackleton said in December 1972: „Man will return to the Moon, it is simply inconceivable that one day other explorers will not follow the Apollo astronauts. All history of exploration shows that any place, once discovered by man, will always be revisited. The Antarctic, or Mount Everest, Australia and New Zealand, let alone the New World, have been explored time and time again". I supported his views fervently and was inspired to write *Startrail* [see Title 244].

Apollo 17 was most successful. Launched 7 December 1972, the official record claimed it as the longest Apollo Mission, 302 hours, nearly 13 days, and it returned to Earth with the greatest load of lunar samples, 116 kilogram. The two astronauts on the Moon, Eugene A. Cernan and the geologist Harrison H. Schmidt, incidentally the only professional scientist to fly on an Apollo Mission, travelled 35 km during three periods of walking and of driving in the lunar Rover. They achieved 22 hours of exploration during their EVA, the extra-vehicular activity in space suits, the longest of all Apollo Missions. Schmidt became very excited when he discovered orange coloured sand near Shorty Crater which, he speculated, might have been formed during relatively recent volcanism, 100 million years ago.

I reported Apollo 17 from London, thanks again to the excellent television facilities of the BBC who had continuous transmission from NASA and generously allowed me to look in. I only wrote a few comments, as the main reports about Apollo 17 originated from Alex Faulkner, the *Daily Telegraph's* New York Bureau Chief who had travelled to Cape Kennedy. I wrote an 'Apollo Assessment', 36 C-C, published after splash-down on 20 December.

Two great achievements, brought about by science and technology, will forever characterise the 20th Century: Atomic Energy and Man's first Exploration of Space. All political strife, all civil wars, even great natural disasters will be forgotten in centuries to come, but perhaps some paintings by Picasso, more likely perhaps a bronze sculpture by Henry Moore, may have survived the ravages of time. The first—and one hopes the last—atomic bombs and the first walk by a Man on the Moon, will forever be unforgettable events in history, as long as human beings live on Planet Earth.

When coal and oil are exhausted and atomic energy will again find its rightful place to provide more energy, then explorers will return to the Moon and continue manned exploration of space. Thus the Apollo Missions, carried out by NASA, the American Air and Space Administration, must be judged and evaluated.

As seen from our here and now, the Apollo Program brought about a managerial revolution in macro-technology which I have discussed in some detail on Titles 164 to 166. The second and quite unforeseen result of the Apollo Programme has been man's discovery of his own planet. When in 1968 the Apollo 8 Christmas message reached us, it was as if man had discovered a new mirror image of himself.

Millions saw their beautiful blue planet on television from space as they had never seen it before, and from that day on men and women became deeply concerned with their responsibility to preserve and safeguard the environment for their future and for their children. It was another revolution which affected all of us, although its origin will have been forgotten in the future. As in so many other scientific endeavours, the unexpected and unforeseen results are often much more significant and long lasting than the immediate objects of the research project.

Not that the actual scientific results were of minor interest, as for example the richness of titanium and the discovery of minute natural glass spheres as well as the complete absence of quartz and water in the 400 kg of Moon rocks brought back to Earth. Their age could be dated as 460 million years, older than any rocks on Earth. Not unexpected was the absence of any trace of life, past or present, but it was surprising to discover the quietness of the Moon with only rare moonquakes, while on Earth there are millions each year, large and small.

But many Moon mysteries remained unsolved, for example why does the back of the Moon with its many craters differ geophysically from its front?

"The Startrail" Title 244

The Startrail began
With the first Man
To look up and wonder.
It began again
With a new refrain
When man reached the Moon.
Our Earth now, in eclipse and despair
Needs Renaissance and repair.

A new faith in the Future
For those that are young
Is Spaceship Earth
On its path through the Universe.
And the Explorers first step
To bridge the gap
Must begin soon.
Beneath the black skies of the Moon

He must spin his cocoon,
To grasp Nix Olympus on Mars
And Alpha Centaurus—the Stars
Man seeks to know
But the voyage is slow.
To the unclimbed mountains of the Moon

Man will return, with his Sherpas of Space
Because it is there, because it is there —
Hadley Rille and North Massif
Once seen by mountaineers
Their challenge
Never forgotten.
For artists' inspiration

Man will return
To the Moon—soon.
For epic poems of
Mare, Rille and Crater
For sonnets of Schröter
And Librettos of Tycho
To sketch and to paint
The Moonscape of Plato
To compose a new Ninth —
The Crater Symphony.

Continued

See Watercolour Title 244, inside Back Cover

To cure the weak heart of the Old
Trips to the Moon will be sold.
Money will yet be found
To mine the Moon's round.
Its unclouded Sun
As tourist attraction
Will earn praise and craze of fleeting reactions.

No life, no trace yet found
Of others on the Moon.
For the next round
On its Far Side
So ideal
For the Radio-Spiel
Of Astronomy.
Man will return—to the Moon
Soon —
Its Origin to learn
For Science to burn.

What price to pay for Immortality?
Who will be next to inscribe his name
In the Moon's Book of Fame?
Explorer or mountaineer
Artist or financier
Or man on his next step to the Stars?

A. R. M. Written in Penzance, Cornwall, 740803

Undoubtedly this was the most extraordinary science story I wrote during my ten years as Science Correspondent of the *Daily Telegraph*. It was published on 2 July 1973. This was to be my last year as an employee of the paper, but the end had nothing to do with this story.

On 30 June 1973 a total solar eclipse occurred in Africa, and as the Moon's shadow raced across the continent, *Concorde 001*, the French prototype of the supersonic jet aircraft, was flying for 74 minutes at 1920 km per hour to keep pace with the shadow, thus allowing scientists aboard to carry out their experiments. With a totality of 7 minutes and 4 seconds on the ground, this was extended to 80 minutes totality by flying supersonic. It was the longest eclipse of the century and as Concorde flew from Las Palmas in the Canaries to Fort Lamy in Chad, it set up a record, unbeatable until the year 2150, when another eclipse of equal duration will take place.

British astronomers were disappointed that the British prototype, *Concorde 002*, could not be at their disposal, but the French graciously invited Dr M. Gadsden of Aberdeen University and Dr J.E. Beckman of Queen Mary College, London, to fly for their observations in the French Concorde. A quartz window was specially installed to allow their infrared research project. Thus far my scientific report about the Eclipse of 30 June 1973.

Any eclipse is news, particularly if visible in Europe, as was the case in the South of England. Being a matter of public interest, the European News Agencies like Reuter, Agence France Presse and Deutsche Presse Agentur collect all possible and impossible aspects of an eclipse and distribute these as news items to their subscribers, like the *Daily Telegraph*. In this instance they all landed on my desk in Fleet Street.

Among them was the following: "In Cairo, Hussein el-Himi, a leading astrologer said: 'The eclipse signals President Nixon's political eclipse—by death, by being ousted from the presidency'".—This I published as an example, how astrology and astronomy are confused.

What happened in fact was that President Nixon revealed on 4 August 1974, one year and one month after the eclipse, that he had participated in hiding the facts about the Watergate break-in and on 8 August 1974, faced with almost certain impeachment, he became the first US President to resign from his office. Hussein el-Himi, although he based his forecast on quite extraneous facts, could not have given a more accurate forecast a year ahead, based on the eclipse occurring on 30 June 1973!

But see Title 377, "A Philosopher looks at Astrology".

When in 1973 the British and French Governments signed a solemn Treaty to allow the construction of a tunnel below the Channel, I considered it appropriate to discuss this macro-engineering project from a scientific point of view. My article was published on 22 June 1973 and given the title "Is the Chunnel just asking for the Moon?" In it I described the reasons for the success of the Apollo Missions to the Moon and asked if Britain had learnt the right lessons for the successful building of the Channel Tunnel.

I was delighted and felt very honoured when less than a month later, I was sent a page from the *Proceedings and Debates of the 93rd Congress*, First Session, dated Washington, Friday July 20 1973. The Hon. Olin E. Teague of Texas had 'read' my article into the Congressional Record and stated that „A recent article by Anthony Michaelis in the *Daily Telegraph,* June 22 1973, pointed out graphically the significance and importance of technology to a nation ... Mr Michaelis graphically demonstrates why high technology programs are essential to the well being of every major country."

Naturally I was very proud and sent a copy to the Editor, Mr Maurice Green. He replied: „It really is something of a triumph to get an article written into the '*Record'*. I have no idea how these things are done. "To this day I have no idea myself and I should have asked, and expressed my thanks to, Senator Teague.

I had pointed out in my article that the primary reason for the Apollo success had resided in what at the time was called by T. Alexander in *Fortune* the 'Management Revolution'. He defined it as „The technique for directing thousands of keen minds in a mutually enhancive combination of Government, private industry and university". I had been greatly privileged to see this technique in action during my many personal contacts with the representatives of the three agencies of the Management Revolution and felt it very desirable that this important lesson should also be learnt by those responsible for the construction of the Channel Tunnel, the British and French civil servants, the contracting companies' executives and academic geologists.

To achieve this revolution, NASA, the American Government's Space Agency, had to develop new control measures to ensure the essential quality control of the millions of separate components of each Apollo spacecraft. In contrast, the Channel Tunnel was being built entirely from private finance and hence had a multitude of separate controls. That in spite of this obvious drawback, the speed of construction and the absence of serious accidents allowed the Tunnel to reach a successful conclusion must be a tribute to those responsible. One year after its opening, I wrote again about it, see *ISR* Vol. 20, No. 1, p. 1. Also relevant is Title 164, "Shared Characteristics of a size Enterprise".

The most unusual assignment I received while working for the *Daily Telegraph* was to act as witness to a radio transmission on board the private Yacht *Idalia* in the harbour of Malta. The yacht belonged to Lord Camrose, the brother of Lord Hartwell, the owner of the newspaper, and it was probably he who suggested me to act on his behalf as an independent observer.

At that time, the early months of 1973, the great British ocean liner *Queen Elizabeth* was equipped with all the possible luxuries a sophisticated transatlantic passenger could wish for, and of course he needed a daily newspaper on his breakfast table. Such a service had been provided by Reuters typed news stories up to September 1972, but had then ceased.

The *Daily Telegraph* management, namely Lord Hartwell, decided that a completely new service should be offered to Cunards, the owners of the liner, by radio transmission of several complete pages of the *Daily Telegraph* every morning. It was an excellent idea and would also prove to be a first-class advertisement to those passengers who might never have seen the newspaper before.

The transmission by radio was in fact an early attempt to provide facsimile, or what is now FAX, normally transmitted over telephone wires, but now easily achieved by wireless transmission to ships at sea. Not so in 1973, and it was decided to try it out, using for this purpose the yacht *Idalia*. Lord Camrose, its owner, had been a keen yachtsman all his life and from 1947 had been honoured as the Vice-Commodore of the Royal Yacht Squadron.

For these facsimile transmissions of complete pages, the TELFAST system had been chosen, and I was to witness its quality in Malta and report as an independent observer on its performance. I flew out to Malta, and a few days on board of a luxury yacht was certainly a welcome experience, although in the middle of February, it was neither sunny nor warm.

Unfortunately the transmission of pages did not go as smoothly as had been hoped. At first the signal was too weak to receive copy, then a fault in the receiver was discovered, then the telephone link between Fleet Street and the yacht was lost. The next day, interference from another signal on the same frequency made reception unusable and it was concluded that the power of transmission by the British Post Office was just insufficient. Morse signals also interfered, and the whole idea of transmission across the Atlantic to the *Queen Elizabeth* on a daily routine basis, had to be abandoned. I reported the failure, but did not realise then that I had witnessed one of the earliest FAX trials to a ship over a radio link.

Apollo 17 was the end of American Moon missions, but as originally two further Apollo spacecraft had been built, these were now surplus to requirement and were converted to a manned space station in Earth orbit. Between May and November 1973, three separate crews lived and worked for 171 days and 13 hours in this station, called *Skylab.* The USA established a new record, as the previous longest period in space by the Russians in Soyuz 11 was 24 days. However, the three Russian crew members were killed during re-entry, and it had therefore not been possible to study the long term effects of living without gravity.

Skylab was not without its own problems, and soon after reaching orbit, its large solar panels, to provide electricity during flight, failed to extend. The first crew was therefore faced immediately after arrival with the daunting task of manually extending the panels, as otherwise they would have been unable to continue. Skylab had several different compartments, working and living space, as well as air-locks and docking facilities. These were necessary, as two separate launches had to be performed, one for the crew and one for the laboratories, which had first to rendezvous and then to dock with each other in space, to become the complete Skylab. It orbited the Earth in a circular path at a height of 430 km.

After the third crew had left in 1973, Skylab was abandoned for 6 years and in July 1979 it re-entered the Earth's atmosphere and disintegrated, showering its debris over the Indian Ocean and Western Australia, where years later some components were found in the desert by collectors.

Although Skylab was designed as a completely independent research station and 91 experiments had to be performed by the crews, its priority function was to evaluate the behaviour of man himself, exposed to long weightlessness. The inclusion of a medical astronaut in the first crew was an indication of the seriousness with which NASA intended to study this aspect.

The observations by the crews and the relevant experiments were targeted on Earth resources, astronomical discoveries and photography of Earth itself. The medical tests were concerned with the astronauts' sleep, length and depth, as well as changes in their chromosomes and blood cells. All these were essential preliminaries, if man was ever to attempt a flight to Mars and even beyond. They would then have to endure many months and years without gravity.

The first manned telescope in space was also an integral part of Skylab, and particularly events on the Sun were observed and recorded. The scientific results of Skylab were enormous and proved once again that with improvisation and conversion of surplus materials, NASA was able to lay a foundation for the future.

In 1973, like previous years, the bulk of my work was to report on what I have called 'Routine Science'. [See alsoTitles 96, 115, 139, 156, 213 and 227]. The great variety of scientific and technological subjects which flow across the desk of a science correspondent can best be judged from the examples listed below. Most of them were published.

SPEED OF LIGHT
DISTRICT HEATING IN NOTTINGHAM
COPERNICUS ANNIVERSARY AT ROYAL SOCIETY
RUSSIAN JEWISH SCIENTIST
HOVER TRAIN'S FUTURE?

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LUNOKHOD 2
HAZARDOUS CHEMICALS CODE FOR FIREMEN
DROUGHT WARNING BY WATER BOARD

MOST DISTANT QUASAR
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ELECTRONIC WARFARE IN MIDDLE EAST
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MR HEATH VISITS DOUNREAY
SOLAR CELLS FOR SAILING BOATS
SCIENCE MUSEUM GETS WELCOME COLLECTION

TATTOOING GOES ON
GROWING MAIZE IN ENGLAND
HEATHROW COMPUTER CONTROL
BARNES CINEMA MUSEUM 10 YEARS OLD
FUTURE OF BUOYS

I was never informed by the Canadian Government why they extended an invitation to me to visit its Northwest Territories in the Canadian Arctic. It was indeed an unforgettable journey, and although I only reached about 75° North, compared with my 90° South four years earlier, it was an exciting and an equally rare opportunity for me to observe and report on the second of the polar regions of our planet.

A further emotional experience was added, namely the reading of the whole *Lord of the Rings*, by J.R.R. Tolkien during my travels. Knowing from experience that there would be many hours of loneliness during the more than 30000 km of flying, and during the many evening hours alone in small and large hotels, I purchased in London a complete pocket edition of this heroic epic. I started on the first page when leaving Heathrow airport, and when I returned to London on the 12 October 1973, 14 days later, I had just read the last page. I felt that my Canadian voyage was a perfect mirror of the mysterious tale which Tolkien had written.

I flew with Air Canada to Ottawa, the federal capital, and stayed in the luxury Hotel Chateau Lauriel for a few days, calling at various Federal Ministries for background briefings before proceeding over thousands of kilometers west and north. The first I saw was Senator Maurice Lamontagne, who had been responsible for the report on *Science Policy for Canada.* He was of the opinion that pure science did not produce innovations for technology.

My next interview was with Dr A.T. Prince, the Director General of the Department of the Environment, who told me about future Canadian plans to bring gas from the Arctic by pipeline to the USA and for expansion of inland oceanography of the Great Lakes, in which Canada was far advanced compared to the USA.

Most interesting were my talks with the officials of the Federal Department of Communications, which had only been started four years earlier. Satellites had brought a completely novel social situation to the Canadian Arctic, providing a real new link with distant fields of civilisation, of education, of medicine and entertainment for the isolated population of the North. Future plans at that time included the development of two-way links by satellite, so that medical emergencies could be dealt with rapidly and efficiently.

From Ottawa to Toronto, with a brief visit to the Pickering Atomic Power Plant and on to the famous Athabasca oil sands. After another flight of one thousand kilometers I landed at Inuvik airport, in the Arctic on 4 October.

Inuvik is Canada's northernmost city, 200 km north of the Arctic Circle and only 100 km south of the shores of the Arctic Ocean. About 4000 people live there, of which one-third are native Eskimos and one-tenth Indians. Although this area of the Mackenzie River's Delta was discovered by the great Scottish explorer Sir Alexander Mackenzie in 1789, who followed the river—later to bear his name—from the Great Slave Lake north to the Arctic Ocean, this Delta was rarely visited until 1954. It was decided to make Inuvik the focal point of my travels, 15000 km from London.

During the time of my visit, in Mid-October 1973, they houses of the little town were shining in a variety of bright colours, not yet hidden by snow. There were other contrasts with the Antarctic, a Mayor instead of an Admiral reigned, children instead of marines were seen on the streets, and its women had 'cabin fever'. But Inuvik also had some problems which did not exist in the Antarctic, rubbish disposal was one, the other alcoholism amongst the Eskimos. As I entered one pub, I walked straight into a brawl.

Dick Hill, the resident manager of the Research Laboratory told me: „In the summer we had 66 research projects going on, ranging from archaeological excavations of the ice conditions in the Beaufort Sea, erosion in permafrost areas, reindeer migration patterns, cosmic ray monitoring, small animal behaviour to the environmental impact of the Mackenzie, the Dempster and the Alaska highway". All were supported by Federal Government Grants.

World War II brought as the first revolution the famous Alaska Highway to this frontier area between the USA and Canada. It had to be bulldozed through a strip of the Canadian Yukon Territory in which the Mackenzie Delta lies. This highway was essential to provide a land bridge with Alaska to ensure its oil supplies. Then the Cold War in the 1950s brought the second revolution and led to the erection of an 8000 km long Radar Chain, the Distant Early Warning, DEW Line, along the shores of the Arctic Ocean. With it came numerous weather stations, and all its construction was based on extensive aerial survey photography. So if not directly scientific, the technological impact on this barren, frozen and distant land was great.

One day Dick Hill chartered a small aircraft to fly with me about 100 km north to Toktoyaktuk on the shore of the Arctic Ocean, where there was a weather station and an Eskimo settlement, both of which he showed me. From there I could clearly see the oil drilling platforms in the Arctic Ocean, the latest technology in the Beaufort Sea. Where once the fur trade of the Hudson Bay Company had reigned, oil and gas were now the desirable resources.

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"Oil drilling from man-made islands in the Arctic Ocean is the latest development to tap the energy resources of Canada's arctic belt". This was the opening sentence of my hand-written report from Inuvik, sent to London and published in the *Daily Telegraph* on 15 October 1973. It was long, 66 column-centimeters, as it also dealt with social conditions in Inuvik and the Canadian satellite *Anik* which brought the outside world to the few lonely inhabitants, including Eskimos and Indians of the area.

Flying with Mr Hill over the Mackenzie Delta, I was amazed by the numerous oil drill rigs, the supply camps and the incredible desolation of the frozen land and seascape. Flying low, I saw clearly two of the man-made islands, one of them of the 'self-destruct' kind, as Mr Hill explained. During the long arctic winter, the sea freezes solidly enough to support the weight of the standard oil drill rig together with its auxiliary equipment. When the operation is completed by the following summer, its sandbag walls are left a prey to the waves.

All supplies and the component parts of the drill rigs are brought by British and Canadian hovercraft to the site and even the production rig, weighing 160 tons, will arrive by special hover barge. It was in the course of construction when I visited Inuvik and Calgary in Alberta, about 700 km south from the drill rigs.

Athabasca oil sands were my next port of call, about 100 km north of Edmonton, the capital of the Province Alberta. After removing a 10 meter overburden by bulldozers, giant bucket wheel excavators load the sand from the open cast mine into 150-ton trucks which take it to the preparation plant. There with the aid of caustic soda and hot water, the tar is made to float to the top and the sand allowed to separate out at the bottom. The tar is then treated with conventional refinery techniques, hot cracked and hydrogenated with hydrogen from natural gas. It is the only deposit of oil sands in the world which is directly linked with an oil refinery. The daily output at Athabasca was 'only' 55 000 barrels, and it left the refinery as a pure petrochemical feed stock, directly suitable as fuel for diesel engines.

Mr Earl Ray, the Manager, showed me round and explained to me how Canada's future depended to a large extent on its vast fossil fuel reserves which in 1973 were estimated as 50000 million tons of coal, 50 million cubic feet of natural gas and 7000 million barrels of oil. This spectacular open-cast mine confirmed to me, as a chemist who had worked in an oil refinery myself [seeTitle 25], how bright was Canada's future.

The 10th anniversary of communication satellites was an event which in 1973 deserved a note to remind me of the progress achieved in such a short time. This type of geo-stationary or synchronous satellite, in orbit around our Planet's equator at a height of 36000 km, circles at the same speed as the Earth rotating beneath it, and hence appears stationary when viewed from below. The satellite can therefore act as a transmitter of signals beamed to it and re-broadcasts them to ground stations on roughly one third of the Earth's surface.

It was the English scientist, famous for his science fiction, Arthur C. Clarke, who in 1945, 12 years before the launch of the first *Sputnik,* suggested that three such synchronous satellites, which he then called 'Extra-terrestrial Relays' could act as transmitters of electronic signals for the whole Earth. More than 700 million people first became aware of their existence in 1969, when they watched 'live by satellite', man's first jumping steps on the Moon.

It was in 1963 that *Early Bird*, [see Title 108] or as it was officially called Syncom 2, was launched from Cape Kennedy and thus started what Isaac Asimov called the "Fourth Revolution". (Speech was the first, the alphabet and writing the second, printing the third, and global electronic literacy the fourth revolution for man). Before the end of the Second Millennium, the Fourth Revolution was completed and world-wide television and broadcasting, telephoning and Fax transmission, had become so common, that it was taken for granted, just as clean water from a tap in the developed world.

In my Anniversary Article, entitled "What satellites have to say" by the sub-editor, I drew attention to the work of the United Nations International Telecommunication Union, the world regulatory body of frequencies, and how the ITU allocated the electronic frequencies for the multitude of satellites which were then, and are now, in orbit above the equator, in ever increasing number and performance. This essential international governing and controlling function began as long ago as 1865 from the first telegraphy onwards. [See Title 69 about my book *From Semaphore to Satellite]*.

This article which was 84 column-centimeters long, was published on 29 October in the *Daily Telegraph*. It was my last contribution to the paper. It carried an inset that I had relinquished my position as Science Correspondent which I had held since 1963 and that I was to be succeeded as Science Correspondent by Clare Dover, my highly competent and much beloved assistant. I was glad for her that at long last she received the recognition that was due to her excellent work. She stayed for many years.

In November 1973 it was ten years, less one month, that I had been employed as Science Correspondent for one of London's best newspapers. *The Daily Telegraph's* reputation during that decade was that it brought more and better news from all over the world than any other paper, and that it had a strong political position in support of the Conservative Party. I accepted gladly the challenge of bringing scientific news from all over the world every day to the attention of the readers of the paper, then averaging 1300000, the largest circulation of a high quality paper in Fleet Street, that is Great Britain.

Travelling 'for news' suited me fine, although I had no experience in the art and craft of a journalist. I learnt it on the job, and as I was unmarried at the time, lengthy absence from London was no problem. Neither the Editor who engaged me, nor I, could have foreseen that this policy would take me to every continent and the two polar regions. I kept a careful account of my travels and at the end of each year I prepared a total, for my own record.

1964	2700 miles	1969	113465 miles
1965	25000	1970	63780
1966	63700	1971	56166
1967	27500	1972	33200
1968	42000	1973	55670
		TOTAL:	483181 miles
			773090 kilometers

This distance is equivalent to almost 20 times around the equator, or taking an average for each year of 48320 miles or 77310 kilometers, I travelled almost twice around the equator each year! Much of the cost of this travel was provided by the frequent invitations I received, either from foreign official sources or industrial public relations departments. All foreign travel was approved by Ricky Marsh, the Foreign Editor, a great friend and colleague.

Mr Peter Eastwood, the Managing Editor to whom I was responsible and whom I disliked as much as he was prejudiced against me, once made the caustic comment that he would arrange for an article in the paper with the headline: „Science Correspondent in London, rare Appearance". Eastwood was much hated by the staff of the Telegraph and as Duff Hart-Davies pointed out in his book *The House the Berrys built* (page 280) Eastwood was "cruel, cold and scheming" and full of social and economic prejudices. He certainly had no understanding of science, and he asked me frequently to report the "bad aspects of science", the pollution, the technological accidents and disasters which he insisted were caused by 'science'.

Travelling to a source of scientific news was only the first step to my printed report in the paper the next day. The second step was to interview a scientist, describing a new accelerator, or a rocket launch, or whatever I considered newsworthy. This step was of course the same wherever I was. The third step was to transmit my typed report back to Fleet Street, which could be extremely easy, if I was able to dictate it over a telephone line to 'COPY', the highly efficient copy-takers or typists, who with minor abbreviations, would produce sheets of 'copy' to go straight to the editorial staff. This admirable system of communication is now superseeded by Fax and electronic mail.

Telephonic communications were only used when there was urgency to reach Fleet Street by the early afternoon, or if there were no other communication facilities available. In my days, telegrams were the normal method of 'filing' from abroad, and for this purpose a credit card of the telegraph company was issued to me. When I wrote my report from home, often essential when I had to consult a book in my library, I invariable telephoned. If I had the material ready in my office, I dictated my report to my secretary who typed it, phoned Copy, who then sent a boy to collect it.

Exceptions to this standard third step were rare. Scientific news do not arise in the middle of a desert, and if they do, there will always be a base camp with facilities for communication. However, in Adis Abeba I had to use a telex machine myself, and in the late 1960s the first primitive facsimile transmission equipment, Fax, had appeared. I used it as a link from Cape Kennedy and Houston to the *Daily Telegraph* Office in New York.

I never had any control over the fourth and final step of getting my report printed. I have often been asked if there was any political censorship by the editorial staff as far as my reports were concerned. I cannot answer this question truthfully. At the beginning of the editorial chain, the *Telegraph* had a 'copytaster' whose task it was to select only about one third from the great flood of nightly reports that had come to his desk in Fleet Street. Two-thirds were simply thrown away, and if this was a kind of 'political censorship', my science reports were selected like all others. I cannot recall any of my articles having a political bias, for or against the Conservative Party, so if my reports did not appear in the next day's paper, I had to assume that other news stories were considered more important than my science contributions by the copytaster.

All newspapers I have ever read have a parochial bias and give preference to local stories. If then I started my report with "The British housewife will benefit from this scientific discovery..." its chances of being published increased greatly!

The one philosophy which seems to apply to all newspapers, apart form adherence to a political persuasion which they desire to impart to their readers, is best expressed by the French term *'morts-kilomètre'*. It is a factor, given by the number of people killed in a disaster, multiplied by the distance in kilometers which separates the event from the place of the newspaper's publication. The distance in this numerical factor, and not the number of dead, determines the space in the newspaper devoted to its record. So for example, 500 people drowned in a ferry disaster in Indonesia will be noted by a single small paragraph. If however 5 children are burnt do death in a house in a neighbouring city, at least a quarter page will be given to this event next day. This may well be a true reflection of the average reader's interest and a correct allocation of space from the point of view of circulation and profitability of the newspaper.

After all, the primary function of a newspaper is to make money for its owners, unless it appears in a communist country. The income derives from the number of regular readers and the number of advertisements appearing in it, which the advertisers only judge on the basis of the paper's circulation. To attract the greatest numbers of readers, the owners or their deputies, represented by the editorial night staff, must therefore select only those items of news which in their opinion appeal to the largest number, often the lowest, common denominator, of readers. It is generally, correctly, judged by most newspapers, including the *Daily Telegraph*, that bad news, fears of war, sex, sleaze of politicians, divorces of famous people, terrorist bombs and financial collapses, sell most newspapers.

Is science then one of these factors? Only if a giant event like a Moon landing, better still astronauts in danger of their lives, or if ever extraterrestrial men or women reach our planet—then indeed would science be the front-page lead story. This happened only once to me, when during the epic flight Apollo 11 of my reports occupied the front page for days on end. Generally my science stories appeared on the inner pages of the paper, sometimes on the top of the page, more often lower down. I can only conclude that science was not considered as one of the factors that would increase the sale of the newspaper.

Whenever an opportunity presented itself, I pleaded with the owner Lord Hartwell, to give me a whole page for science once a week so that its benevolent, or occasional malevolent, influence could be properly judged by the reader. That I was correct in my demand was shown by the fact that after the sale of the *Daily Telegraph* in 1986 to Conrad Black, the new owner, allotted to the next science correspondent, Dick Fyefield, a weekly science page.

Chaim Weizmann, born in 1874 in Western Russia, brought up as an orthodox Jew, studied chemistry in Germany and Switzerland and obtained his PhD from the Fribourg University in Switzerland in 1900. At the age of 30, he came to England and was received by W.H. Perkin at Manchester University, where Weizmann joined the staff and for many years carried out research work and taught organic chemistry. He had been a devoted adherent of Zionism all his life and World War I gave him his chance. By 1916 a severe shortage of acetone, a vital chemical in the manufacture of cordite, the smokeless powder used by the Royal Navy, had occurred.

It was Weizmann who found the solution, the fermentation of starch to produce acetone with a micro-organism, *Clostridium acetobutylicum* which he had discovered. For this important service to Great Britain, for which Weizmann wanted nothing for himself, Lloyd George the Prime Minister and Lord Balfour the Foreign Secretary, promised Zionism a National Home for Jews in Palestine. This was the famous Balfour Declaration of 1917. But it was not until 1948 that the State of Israel came into existence. [See my booklet *Weizmann Centenary,* Anglo-Israel Association, 1974.]

When Israel Sieff wanted to commemorate the death of his son Daniel Sieff, Weizmann advised him to establish a small laboratory in Rehovot, Palestine, and to name it after his son. It was opened in 1934 and was imbued with the 'spirit of excellence' on which Weizmann insisted all his life. It was renamed 'Weizmann-Institute' in honour of his 75th birthday and has grown into a world-famous research institute. Weizmann became the first President of the State of Israel in 1949, only the third scientist who also deserved the title of Statesman. Benjamin Franklin and Jawaharlal Nehru being the only two others in my opinion.

I had first visited the Weizmann Institute in May 1959 as Editor of *Discovery* [seeTitle 64] and there met its leading scientists, who were to become good friends during subsequent visits. As much of the budget of the Institute had to be raised by voluntary donations, its public image had to be of the highest level and to achieve this, the Weizmann Institute Foundation was established in London. When I left the *Daily Telegraph* in 1973 my good connections with the Weizmann Institute were useful, and I was offered the Directorship of the London Foundation.

In this capacity, I started an annual Weizmann Lecture to be given at the Royal Institution by a leading scientist from the Institute and scientific visits to Israel by British schoolboys and girls for the summer vacations, to participate in scientific work in Rehovot. Both proved successful for many years and are still in operation, as far as I know.

See Watercolour Title 258, inside Back Cover

Administering a small foundation was very different from the work of a Science Correspondent, and after a short time I found that I was bored and frustrated. The only relief was the occasional visit to the Weizmann Institute in Rehovot, Israel, and meeting there the many outstanding scientists in different disciplines. These were always great days, often combined with travels in Israel, as for example after the War with Egypt in November 1973. The Israeli Army had then occupied large areas west of the Suez Canal and bridged the Canal itself with a pontoon bridge, which a group of Institute scientists could use to cross the Canal on an excursion of which I was a member.

Fortunately a new perspective appeared soon. One of my friends, Dr Peter Farago, then the Editor of the *Educational Journal of the Chemical Society* in London asked me during a lunch if I was interested in starting a new scientific Journal with him, as he had met a publisher, Gunter Heyden, who was willing to underwrite such a project. Heyden then published about 15 Journals, most of them in the field of spectroscopy, and he was anxious to expand his stable. The idea greatly appealed to me and I asked to meet Heyden. I liked him, he too had been born in Germany, and was equally happy to be in England.

He lived in Hendon, North London, and near his home he had installed the offices of his staff, then about 10 in number. Soon after I met him in 1974, he was able to expand and the nearby empty premises in Hillview Gardens of the defunct British Launderers Research Association, were acquired, converted into offices and proudly named 'Spectrum House'.

Once it was agreed that a new Journal should be published, Peter Farago and I faced the task of finding an appropriate name for it. *International Science Reviews* was our first choice until we found that such a Journal existed already. However, we thought that its short title *I.S.R* was admirable, and we had to search for another adjective beginning with 'I'. *Interdisciplinary* came to mind and conveyed to us the freedom of choice for contributions. More important was the situation, of which we were convinced, that interdisciplinary articles were much needed and not catered for in the then existing scientific literature. ***Interdisciplinary Science Reviews, ISR,*** was decided on as the official name of the new Journal.

We conceived another new idea: 'The Modified Referee System'. This consisted in asking a prospective contributor to submit to us a synopsis of 500 words which we would pass on to five members of the Editorial Board for their comments. We argued correctly that, if a contributor could fully and clearly present his thesis in only 500 words, he was likely do so in a 5000 word review. This system saved a great deal of time [see Title 283] and proved highly successful, although I have never heard of any imitation.

We were a team of four to carry out the considerable preparatory work for our new Journal, now affectionately called *ISR* by all. Gunter Heyden was the publisher, Peter Williams his technical manager, and Farago and myself the Editors. Heyden as the publisher of the quarterly Jounal for the first seven volumes, or years, was of course in overall charge. His ebullient disposition, his unconventional approach as an outstanding salesman, his generosity over financial control of the whole project and his highly imaginative approach to advertising ISR, made him an ideal founder publisher for a new Journal. Not once during the seven years did he ever interfere with the editorial contents.

We had determined right from the beginning, that ISR would publish three kinds of contributions:

> Articles emphasising the interactions between two or more natural sciences, or technologies. Reviews of the effects of science and technology on Society. Contributions which furthered the cultural and intellectual links between science, the arts and the humanities.

This ground plan remained the operational methodology for the first twenty years of ISR, while I was the Editor, and it is now being continued by my successor, Jack Harris FRS, with great success.

We demanded from our authors the highest excellence in scholarship and this was to be matched by an equally high standard of printing, layout and design. To fulfil this high level of presentation was the responsibility of Peter Williams, the only Englishman of the team. (Peter Farago was a Hungarian by birth.) Gunter's long experience in the world of publishing and especially of typography and printing ensured that ISR received generous praise not only for its contents, but also for its style and appearance. His original specifications have remained in force for all subsequent publishers and printers of ISR up to the present time.

Dr Peter Farago, a chemist by academic discipline like myself, is gifted with an originality and unconventionality of thought, like most of his countrymen. He brought to ISR an acquaintance of many great scientists who agreed to join the Editorial Board and his numerous valuable suggestions helped me greatly during the first year of ISR while we were Joint-Editors. Both Peter Williams and Peter Farago left after a relatively short time, and the responsibility for ISR, for design and appearance as well as contents rested on Gunter Heyden and myself.

All manuscripts for books or journals, had to be sub-edited for consistency and marked up for the printer. Cecilia Gould, a member of Heyden's staff performed this task excellently.

Few endeavours in life achieve excellence—if they do it at all—only after lengthy exertions and after many years. For our new Journal there was a chance, in fact a necessity, to start with excellence in the first quarterly issue. We decided that there was only one way, namely an Editorial Board of the highest eminence in science.

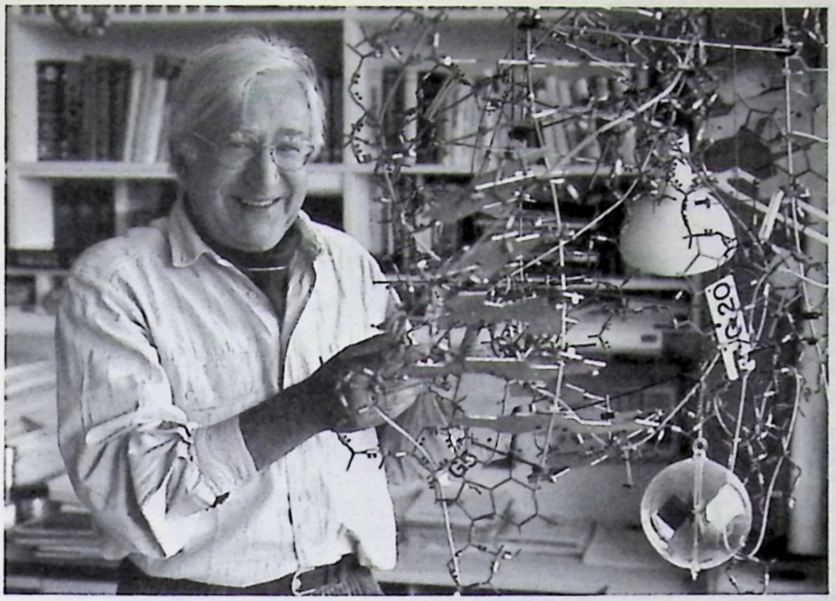
Farago and I therefore wrote or talked to those of our friends whom we considered as eminent and who we thought would be helpful. We pointed out the kind of articles we wanted to publish, and told them that their taste would be small, occasionally reading the 500 word synopsis of a proposed article, our modified referee system. We could not offer any kind of payment, only a free subscription to the Journal, and a splendid annual lunch or dinner at an Oxford or Cambridge College or a London Club, at least for the first 15 years.

We were both pleasantly surprised how many acceptances we received to our invitations. As our reviews were to be concerned with so many different scientific disciplines, we aimed at a large Board, so that at least one subject expert could referee each 500 word synopsis. It was my practise to send the synopsis to five members of the Board, and in case of disagreement, to accept the majority verdict.

Once again I should lihe to express my warmest thanks for the unselfish manner in which the Members of the Board have helped me through the many years since the Journal's foundation in 1975. Sadly many of them have died and have been replaced, but those still alive, now only 22 of the original 70, have remained faithful to the spirit of the Journal.

One other way to proclaim the excellence of the Journal in its first issue was open to us—Messages of Welcome from the Presidents of the Royal Society London, the National Academy of Sciences Washington, and the Max-Planck-Society, Munich. Lord Todd wrote: "Today interdisciplinary research is almost universal." Dr Philip Handler wrote: "That which falls 'between the conventional disciplines' should become everyone's business" and Professor Dr Reimar Lüst commented: "Communication between scientists is an essential part of science in a time of growing specialisation."

"A good review is the moral equivalent of teaching" as Dr Maurice Goldhaber, when Director of Brookhaven, used to say to his staff. True, but so far most reviews were written to teach scientists their own discipline. It was one of the aims of ISR, we pointed out, to spread the knowledge of the interdisciplinary approach widely to all scientists reading the Journal.



Title 262

Professor Dr Friedrich Cramer, for many years Director of the Chemistry Department of the Max-Planck-Institute for experimental Medicine in Göttingen, has been a Member of the ISR Editorial Board since its inception in 1976. In his office he stands next to a model of a Transfer-RNA molecule which played an important part in his researches. In recent years his interdisciplinary interests have been devoted to the theory of time which he published in ISR. *Courtesy MPG Press Department.*

The First Editorial Board, ISR 1/1, 1976 Title 262

ISR
INTERDISCIPLINARY SCIENCE REVIEWS

Editorial Offices Interdisciplinary Science Reviews, Spectrum House, Alderton Crescent, London NW4 3XX, U.K. Telephone 01-202 5333. Telex 28303

ISR VOLUME 1 NUMBER 1 MARCH 1976

INTERDISCIPLINARY SCIENCE REVIEWS

MESSAGES OF WELCOME FROM
Lord Todd, *President of the Royal Society*
Dr Philip Handler, *President of the National Academy of Sciences*
Professor Dr Reimar Lüst, *President of the Max-Planck-Society*

HEYDEN

Title 263

Cover of the first Issue of ISR, containing the Messages of Welcome and the scoop of the first English description of the natural atomic reactor at Oklo in Gabon.

ISR 1/1 *Oklo, the Prehistoric Atomic Reactor* Title 263

On 29 March 1976, the first issue of *Interdisciplinary Science Reviews* was published and copies were given out at a Press Conference at the Royal Society in London. It represented the final climax of 18 months of hard work and was not achieved without a last-minute drama. The printers, J.W. Arrowsmith of Bristol could only deliver the first batch of copies during the late afternoon of 28 March, and therefore Gunter Heyden and I had to drive halfway to Bristol to meet the lorry bringing us copies of the Journal.

Our team of four, Gunter Heyden, Peter Williams, Peter Farago and myself were very proud of the handsome appearance of our publication, with its three yellow horizontal bands across the front cover and the contents list filling the space between the bands. This design has remained the standard ever since then, now for more than 20 years. Only the colour of the bands and the background colour of the cover have changed from time to time.

The first page was a repeat of the contents list, its second page contained the three messages of welcome and on page *iii* the Editorial by the Executive Editor [ARM] and the Consultant [PF] began. We called it *Future Affirmative*. We defined what we called interdisciplinary science, gave a brief history how this concept had arisen from Operational Research during World War II and how it had developed into Systems Engineering. We gave the specifications of the three types of articles which we were going to publish and used the articles in the first issue as our examples.

We were particularly proud of the article The Oklo Nuclear Reactor: 1800 Million Years ago* which was the first description in English to appear anywhere in print. (An article about this natural atomic reactor had been published in French before, but even the *Scientific American* did not give an American version until many months later.) It was a real scoop in the first issue! I had been to Gabon in West Africa where the Oklo River gave the name to the large open-cast uranium mines in which the prehistoric natural reactors had functioned so long ago.

I had taken part in the 'International Symposium on the Oklo Phenomenon' which took place at Libreville, Gabon, in June 1975, where I had met the author of our article, M. Roger Naudet from the Centre d'Energie Nucléaire, Saclay, France. I was able to persuade him to write how he had contributed to this amazing discovery, and his manuscript was translated by Peter Farago just in time for the first issue of ISR. I had a special map of Gabon drawn for this article by Frank Horrabin, the well-known British Map Artist.

* Title of Article in I S R Journal (*...*).

I called my second Editorial in June 1976 in ISR *The American Bicentennial In Default.* I had heard during a recent visit to the States that the 200th Anniversary of the Signing of the Declaration of Independence in July 1776 was to be celebrated by 25000 contests, competitions, commemorations, ceremonies, convocations and commissionings, officially called "American Revolution Bicentennial". All these were listed in a *Master Register of Bicentennial Projects.* I was convinced that none of these activities would be remembered in one, let alone 10 or 100 years, and therefore I called it a 'grave default'.

I suggested that the foundation of a "New Institution" should take place, similar to the existing Smithsonian Institution. The new mandate should be: "The Use and Application of Existing Knowledge", as vague as the mandate of Smithson was in 1826 "The Increase and Diffusion of Knowledge among Men". [SeeTitle 278] By now, in 2001, after only a quarter of a century, the Bicentennial has long been forgotten and there is still no New Institution.

Unquestionably, the most innovative and outstanding contribution to the second issue of ISR was Matthew Huxley's *Criteria for a Socially Sanctionable Drug*. Matthew is the son of Aldous Huxley and Maria Nys and at the time of his writing was Chief of the Standards Development Branch of the National Institute of Mental Health at Bethesda near Washington.

His professional work had brought him into close contact with the prevalent drug abuse epidemic in the States, and he considered it high time to urge the production of *Soma*, the socially sanctioned drug, which his father, Aldous Huxley, had so fully described in his classic book *Brave New World*, published in London in 1932. Matthew Huxley mentioned in his article a number of psychedelic pharmacologicals in existence, like LSD, but did not specify the chemical constitution of the new *Soma.* He did suggest, however, an anti-soma.

Matthew Huxley devoted his seven-page contribution to the full analysis of the novel social factors which would arise through the existence of *Soma*. He enumerated the safety criteria under the headings of purpose, person, place, provider and product. He considered the social problems and discussed in detail excessive and continuous use of *Soma*, duration of effect, the identification of *Soma*, the intake routes and methods, and the matching of *Soma* to special social conditions. He concluded by asking the pharmaceutical industry to provide three kinds of *Soma*, a socialiser, a metaphysic and a sensualiser, each having its built-in individual and social safeguards. Had Matthew Huxley's suggestions been followed, no other article of the over 1000 I published as Editor would have had a more beneficial effect on society. The best of The Sientific Temper. [See also *Drugs—Religion's Chemical Surrogates* Title 373]

At the Annual Convocation of Markle Scholars in 1974, Dr Philip Handler, the President of the National Academy of Sciences in Washington, delivered an address, which I was able to publish in September 1976 in an expanded form, entitled *On the State of Man*. He saw the real threat to the survival of man in its population growth, and analysed the relevant factors of starvation and disease, food shortfalls, an altered world economy, energy and food costs, water as a limiting factor, a changing climate, birth control and urbanisation, as well as his conclusion which he called 'The plight of the fourth World'. He concluded his 14-page article by urging a maximum scientific effort to overcome the thousand challenges facing mankind. [See Title 378]

In his article occurred the phrase: "Can the peoples of Asia be saved from uncontrolled population growth or must Nature be allowed to take its course?"I took the second half of this sentence for my Editorial and called it *Let Nature take its course?* I could only underline Handler's sadness that in spite of our great scientific and technological knowledge, there were still millions of starving people on our planet. I suggested the use of satellites to bring education to Indian villages, and if the experiment then going on, was successful, a world wide extension of it. [See Title 277]

Dr Joseph Needham, FRS and Fellow of the British Academy, was a Member of the ISR Editorial Board and contributed an outstanding article to the October 1076 issue of ISR. Needham, an eminent biochemist, had been Head of the British Scientific Mission to China during World War II, from 1942 to 1946, and on his return to Cambridge, he decided to write a book on *Science and Civilisation in China,* using his library of Chinese texts which he had collected during his stay there. When writing his article for ISR, he was the Master of Gonville and Caius College, Cambridge, and had published the first five volumes of what has justly been described as 'the greatest work of scientific scholarship of the century'. At the time of revising these lines, in 2001, I have 18 large volumes of his great work in my library and there is as yet no end in sight.

Needham was a gentle and kind giant among the truly great scientists whom I had the privilege of meeting in my life. He died at the age of 95, in 1995. [See Titles 374 and 400] In his 13-page article, entitled *The Evolution of Oecumenical Science* he asked the basic question: 'At what point in history, did the Western form of a particular science overtake the Chinese form?' He considered the examples of physical sciences, of botany, chemistry and medicine and concluded as a tentative *Law of Oecumenogenesis*: "The time elapsing between the beginning of a branch of European Science and its fusion with the Chinese form to grow into the universal oecumenical body of modern natural science, is proportional to its biological content." He drew a graph of the Law which clearly showed the fusion of the disciplines.

ISR 1/4 *Associations for Advancement of Science* Title 266

During 1976 I was privileged to attend three highly interdisciplinary Meetings, the American Association for the Advancement of Science, AAAS, the British Association for the Advancement of Science, BA, and the Gesellschaft Deutscher Naturforscher und Ärzte, GDNÄ, in Boston, USA, Lancaster, England, and Stuttgart, Germany. I am certain I was the only science writer attending all three conferences and I wrote a long and critical Editorial about these meetings for the December 1976 issue of ISR.

I found all three Associations parochial. They did not realise that science was no longer advanced through their meetings which suffered from the lack of a true aim or a real function. Science was being attacked by politicians and the media; neglected if not ridiculed by youth; and thus science found itself without a real champion, which the three Associations should be. These criticisms were true for all three Associations and I looked in vain for international co-operation to rectify these omissions.

I suggested ten points of remedial actions at the end of my Editorial and later in 1987 [seeTitle 353] I myself called an International Meeting in Hanover to form an International Association. However, sad to report now (in 2001), that neither my ten points of reform, nor the International Meeting, has produced any change. The scientific establishments in charge of the AAAS, BA and the GDNÄ are all too conservative to recognise the need for reform.

I must mention here the exception, namely the excellent speech by the President of the Federal Republic of Germany Scheel who personally addressed the GDNÄ in Stuttgart in 1976. He urged politicians to take the trouble and learn to understand science, so that they could distinguish between scientifically based predictions and non-scientific divinations inspired by panic, an essential prerequisite for the politicians of tomorrow. Similarly scientists must learn to think in political terms, so that they can evaluate the political consequences of their research work. President Scheel, the Head of State of Federal Germany, supported the Editorial Policy of *Interdisciplinary Science Reviews.*

Two other excellent interdisciplinary articles were published in the fourth and last issue of the first volume: Dr Peter Witt of Raleigh, North Carolina, reported on the design and engineering of spider webs, and how these were altered when psychodelic drugs had been administered to spiders, a subject he had specialised in for many years. Secondly, Professor M.R. Bloch of the Ben-Gurion University of the Negev, Israel, recalled the vital role which ordinary salt, NaCl, had played throughout human history and how control over the supply of salt was power over life and death of whole populations in the past.

Life begins at Sixty (I) Title 267

I have no idea who told me that 'Life begins at Sixty', but it was certainly true in my case. I was 60 years old on 22 August 1976, and during that year a new epoch began in my life with the publication of *Interdisciplinary Science Reviews.* Being an Editor was certainly different from being a Science Correspondent, and I was now totally responsible for the publication of any article either written by myself or any author's contribution which I had invited. No longer could a sub-editor or a night-editor decide.

Physically my life did not change—I continued to live in my pleasant maisonette at 18 Park Place Villas, in 'Little Venice', the district dominated by the old Grand Union Canal, built at the beginning of the 19th Century. Before the existence of railways, bulk goods like coal or quantities of manufactured items were transported throughout England in narrow, 'Long Boats' hauled by teams of horses along the canals and through many locks.

The canals were very narrow, and to turn the boats around at the end of their journey, a large basin was required. The district in north-west London had an artificial lake, called Paddington Basin, and this as well as the adjoining canals gave the name of 'Little Venice' to the area. All streets were lined with trees, and thus the houses had a very distinctive character. The estate agents called them 'very desirable residential properties'. I had been lucky to rent half a house, a maisonette, which was soon crowded with my collections, mostly of antique books on shelves, from floor to ceiling.

I had many friends for whom I occasionally cooked dinner, and I was proud when they, also occasionally, enjoyed the food. I used to tell them "Cooking is but applied chemistry". My best friend was Professor Frank Sondheimer FRS, an organic chemist who had made a special study of annulenes, ring-compounds, like benzene, but instead of 6 carbon atoms in the molecule had from about 14 to 22 carbon atoms. He had worked for a time with Arthur Birch and Carl Djerassi, at Syntex, the American Company responsible for marketing the first birth control pills. [See Titles 6 and 7]

As Syntex prospered greatly, Frank, Arthur and Carl became very rich, but Arthur worked in Canberra, Australia, and Carl in Stanford, California, all as Professors of Chemistry. It was only Frank with whom I could establish a true friendship. When he first came to London from the Weizmann Institute in Israel, where I had met him, he had a magnificent penthouse flat. He was a Royal Society Research Professor at Cambridge University and later moved to University College, London, where we could met often and share our passion for antique scientific books. However, Frank specialised only in antique first editions of chemistry books, whereas my collection was interdisciplinary, embracing all possible scientific disciplines, even science fiction.

At 60, in 1976, I was able to collect antique scientific books more easily, having left the *Daily Telegraph,* but I could never equal Frank Sondheimer. With his ability to buy rare antiquarian and very expensive books, he acquired, after a great effort, a complete set of first editions of the Hon. Robert Boyle's works, a superb and surely unique private collection. I could shared his pleasure, but of course my collection was not comparable to his, although I too learnt much about the history of chemistry. Frank's tragic death made me very sad, and his wife sold his collection by auction, when it was dispersed again.

Apart from starting ISR, there was a second great beginning of my life at 60, when I was able to establish a permanent relationship with Stefanie Maison, something I had not achieved since my divorce. She is a Director of a London Art Gallery, and since 1988 we have lived happily together and shared most of our pleasures. The first holidays we spent together were in Cornwall—not a success—but during our first joint travel abroad, Easter 1976 in Taormina, Sicily, we we had a great time driving around in our tiny Fiat car which we had hired. But when I had to drive across an almost dry river bed, I remember I frightened Stefanie considerably and she got out of the car.

The great event of 1976 was of course my 60th birthday, celebrated at the Abbey Hotel in Penzance, Cornwall. The owners of the hotel were old friends, and they spared no effort to make the festivities in their garden a memorable occasion. My 'brother' Mike Michaelis came from America with his friend Margaret, who wore an unforgettable long white knitted dress. Frank Sondheimer and his wife Betty came from London by train, an unusual method of travel for them, as usually they went everywhere by a car or aeroplane.

The party was not on 22 August, but on 7 August. In Cornwall I had a good friend, Hans von Blixen-Finnecke, whose 60th birthday was at the end of July, and 7 August was half-way between our exact birthdays. This arrangement made our joint party larger and easier to organise. Hans was a Swedish Baron, who had been a Colonel in a Swedish cavalry regiment and a rider in the Swedish Olympic team. He had retired to a lovely old house in Boswinney near St Ives in Cornwall. He was completely unassuming, and occasionally taught dressage in British and American riding schools.

The party was a great success and 60 guests consumed 60 bottles of red wine. I also remember that a camera lens was lost in the garden for a time, and everyone was frantically searching for it—a novel party game. (It was finally found). The Abbey was certainly fully booked for the night and festivities continued over breakfast.

Travel for ISR in 1976 was by no means as hectic or as frequent as before, but Gunter Heyden was very generous with my travelling expenses. I travelled twice to the USA, once in February to attend a Meeting of the American Association for the Advancement of Science, the AAAS, in Boston and again in July to Washington. In Boston I was able to invite a number of the speakers to contribute their lectures to my new Journal and found general benevolent approval for it, when I showed them a lay-out.

Much encouraged by this, I gave on 28 February the first small dinner for the Editorial Board at the Cosmos Club where I enjoyed reciprocal guest status from my London Savile Club. I cannot remember exactly who came, but Michael Michaelis, Ed Creutz, Michael Collins (of Apollo 11 fame) and Derek Price were certainly there. We did no reach any vital decisions, but talked generally about the future of the Journal, and they gave me some good tips.

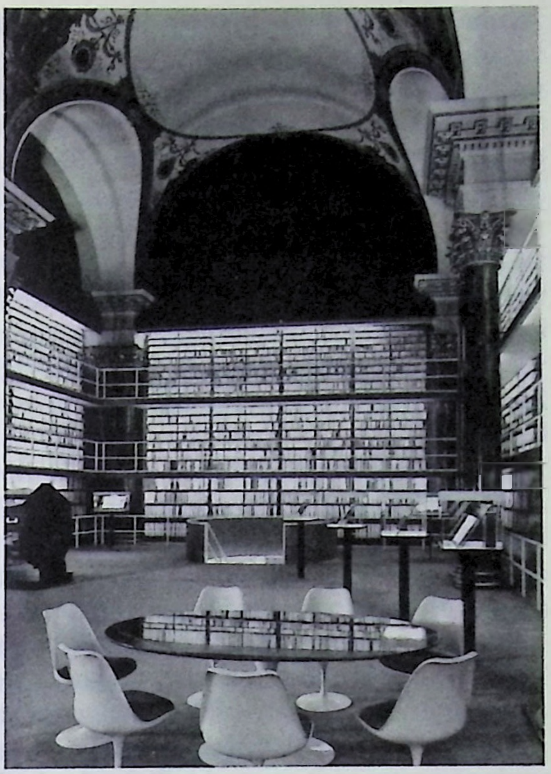
Michael Collins, the first Director of the brand new Air and Space Museum in Washington, gave me an invitation to its opening by President Lyndon B. Johnson and I was proud to attend. The Museum, spacious and gracious, as I described it in my note in ISR, was in fact opened on 1 July 1976 by a radio signal sent to Washington from the Mars-orbiting *Viking I* spacecraft, which operated the ribbon cutting ceremony. The construction of the building cost \$ 40 million and it was completed before schedule and at lower cost than estimated. "One of the few federal projects of this magnitude to achieve this distinction" as President Johnson said in his speech.

In May I visited Members of the Editorial Board in Europe, Erich Schmidt in Vienna, Wolfgang Gentner in Heidelberg, Friedrich Cramer in Göttingen, and G.W. Rathenau in the Netherlands—all received me most pleasantly and promised to contribute to the Journal, which they did in due course. In April we had a formal dinner of the Board in Clare College Cambridge of which Lord Ashby was the Master. After a culinary feast, I reported progress and this was followed by a general discussion and suggestions of future articles by the Board. This remained the standard procedure in the following years.

In September I attended the British Association Meeting in Lancaster and also the Meeting of the Gesellschaft Deutscher Naturforscher und Ärzte in Stuttgart. Both proved very useful for obtaining contributions to the Journal and a relatively easy task, as few of the distinguished speakers had made any previous preparations for the publication of their lectures on which they had spent so much time and trouble. This was my general experience, and in this way I was able to build up my 'capital' of manuscripts for later issues of the Journal.

Title 269A

The "White Walls" of the **Herzog August Library** in Wolfenbüttel, consisting of the vellum bindings of its books, the large volumes on the lower shelves, the small ones at the top, just as its founder August, Duke of Brunswick, wanted them to be arranged in 1644. Among its famous Librarians was G.W. Leibniz from 1691 to 1716, and it was never plundered in the four centuries of its existence. *Courtesy Herzog August Library.*



At that time in 1976 my close friend Carsten Salander, now Professor at the University in Clausthal, was living in Hanover and, being a splendid host whenever I visited him, he showed me the great attractions of his region. I was most impressed when he took me to the ancient town of Wolfenbüttel, famous for the Herzog-August-Bibliothek, one of the greatest libraries in Europe.

With about 3000 incunabula, and almost 8000 ancient manuscripts, it dates back to 1644 when Duke August the Younger, the Herzog of Braunschweig-Wolfenbüttel (1579-1666) brought his private library, the *Bibliotheca Augusta* of 130000 items, to his new residence, Wolfenbüttel. Duke August was one of the rare examples of a scholarly prince, the author of a book on chess *The Game of Kings* (1616), a nine-volume work on cryptography in Latin (1624) and a work on the *Life of our Lord Jesus* in 1640. In the 17th century he was one of the most important collectors of books.

During the following three centuries, the Library grew to over 300000 items. The additional ancient bibliographic treasures, collected by its two famous Librarians, G.W. Leibniz (1691-1716) and G.E. Lessing (1729-1781), as well as by its then incumbent Director Paul Raabe, continued to add greatly to the Library's fame amongst scholars all over the world.

Carsten introduced me to Raabe, a scholar and a great modern librarian, since 1968 Director of the Library, who had added new buildings to house the Library's ever—increasing contents, and expanded it with a special Research Institute and a programme of cultural activities. When I first visited the Library, he showed me the ancient centre, a large and tall circular building, with its three galleries and its impressive 'white contents'. On closer inspection one saw that, from floor to the high cupola above, it consisted of white vellum bound books, stacked according to size, the largest at the bottom, the smallest high above, as Herzog August had arranged them. An unforgettable sight.

During its more than three centuries of existence the library had never been plundered, although Wolfenbüttel had been occupied by the Kaiser's soldiers as well as by French armies during many wars. Were their commanders so uncultured and illiterate, perhaps? However, the *Bibliotheca Palatina* in Heidelberg, as magnificent as the Wolfenbüttel Library, was robbed by Tilly and his Catholic Liga in 1621 and transported on the back of mules over the Alps to Rome, where until today, it is part of the *Biblioteca Apostolica Vaticana*.

Once Raabe kindly asked me to organise a Seminar on 'Interdisciplinarity' at his Library, but I failed to make it a success and no publication resulted.

ISR 2/1 Lord Ashby on *Clean Air for Britain* Title 270

For the first Editorial of the second volume, in January 1977, I returned to *The Infamy of Disaster Relief* about which I had written previously [see Title 81]. I had pleaded in vain for the establishment of an International Rescue Organisation, the I R O and had concluded that neither Governments nor voluntary organisations had any interest in a more modern, scientifically and technologically organised manner of rescuing the thousands of sufferers from natural or man-made disasters which were bound to occur during the future.

In this Editorial I suggested that the World Health Organisation should take on the function of an IRO and employ the Medical Services of the Armed Forces of its Member States. It appeared to me an exceedingly simple and workable solution to the problem of efficient and speedy disaster relief, but, as I had expected, an Editorial in a scientific Journal cannot fight international bureaucracy and the UN Establishment.

Lord Ashby FRS, a founder member of our Editorial Board, had been the first chairman of the Royal Commission on Environmental Pollution and together with the historian Dr Mary Anderson contributed three articles on *The Historical Roots of the British Clean Air Act, 1956*. The first contribution on *The Awakening of Public Opinion over Industrial Smoke 1843-1853* had appeared in ISR 1/4 and his final article on *The Ripening of Public Opinion 1898-1952* was published in ISR 2/3. The second article which was in issue, ISR 2/1, was entitled *The Appeal to Public Opinion over Domestic Smoke, 1880-1892*. These three articles were later expanded by Lord Ashby and Dr Anderson into a book for the Cambridge University Press.

In this, his second article, Lord Ashby wrote that by the 1880s it had become evident that the severe 'pea soup' fogs in London was smoke caused by domestic fires, which were not covered by any laws. A succession of severe fogs, coupled with the publication of mortality rates, equal to those of cholera, led to the creation of a smoke abatement lobby. The work of this group and its sustained efforts, ten attempts in nine years, was then described.

The choice before Londoners, he continued, was either to change from open fires to closed stoves burning coke or anthracite, or to continue to enjoy the 'pokeable, companionable' open grate at the cost of fogs, causing deaths, illness and paralysis of transport. In the 1880s the technology for smoke control was available, but social resistance prevented its application. As Editor, I contributed a drawing, 'Bird's eye view as seen from a balloon, 1884' which showed dramatically the extreme air pollution of South London. The Clean Air Act of 1956, and central heating by oil or gas, ended the London fog.

I have always had a great admiration for the works of H.G. Wells and during my book-collecting days was able to assemble a complete set of his first editions. This collection is now in the library of the Athenaeum Club, London, thanks to the generosity of my good friend David Fishlock.

Nothing in Well's voluminous writings impressed me more than his succinct phrase "Adapt or perish, that is and always has been, the implacable law of life for all its children". I took it as my text for the Editorial in ISR 2/2 in which I pleaded again for the interdisciplinary co-operation between scientists and politicians to solve the great problems facing mankind at the end of the 20th century, like the prevention of nuclear war, pollution of the environment, exhaustion of raw materials, population explosion and the change of climate.

I asked if scientists and politicians could adapt to each other's all too different philosophies and compared their various education, training and professional knowledge. I quoted again Herr Walter Scheel, the President of the German Federal Republic: „Only together can science and politics understand and master the future, in all its intellectual and moral, its cultural, economic and political perspectives."I had to conclude that the *Implacable Law* rules us all and that the alternative was *Adapt or perish*. [See also Title 146]

Of all the excellent contributions to this issue I find that Professor Heyman's article on *The Gothic Structure* demonstrates best the thoughts of an interdisciplinary scholar, applying modern engineering knowledge to the solution of a mediaeval problem. He started by pointing out that the outstanding feature of Gothic buildings was the fact that most of them still stand today. They had survived earthquakes and even the bombing of World War II, most of them only slightly damaged, while surrounded by totally destroyed cities.

His scholarly analysis of Gothic Architecture ranged widely, from the Duomo of Milan, Notre-Dame de Paris, Kings College Chapel, Cambridge, Sainte Chapelle, Paris to the amazing cathedral of Beauvais. This, built between 1247-1272 stood for 12 years and then collapsed, probably due to foundation problems. It was rebuilt by 1569 with an enormous masonry tower, 153 m from the ground, and it was a continous cause for alarm until it came down four years later.

His engineering analysis was very scholarly, stresses in vaults, thrust and counterthrust, arch and masonry theory, hinge formation, plastic theory, distortion and structural action. Heyman most important conclusion was that the structural action of masonry, and its survival, must be related to the geometry of the structure, and not to stress.

ISR 2/3 Medawar's *Effecting all Things Possible* Title 272

This was the Presidential Address to the British Association Meeting in Exeter in 1969 which Medawar gave two days before he suffered his fateful heart-attack in Exeter Cathedral which I had to report. [SeeTitle 186] Medawar, a Nobel Laureate for his contributions to the science of immunology, had been a member of our Editorial board since its inception.

He took the title from Francis Bacon's *New Atlantis* (1627), and his purpose was to compare the philosophy of the 17th century with the present and to ask why this did not bring us reassurance, as it done more than 300 years before. Amidst the philosophical gloom of the 17th century, Medawar continued, there were new voices of confidence such as human reason, and what human beings might achieve through an understanding of Nature, and a mastery of the physical world. An early example of the Scientific Temper.

"Once again we are oppressed by a sense of decay and deterioration, but this time, in part at least, by a fear of the deterioration of the world through technological innovation". Referring to the great sidereal adventures of today, Medawar thought them both elevating and frightening, as he compared an Apollo rocket on its launch tower to the shape and grandeur of a cathedral's spire. Both are economically pointless, a shocking waste of public money, but also symbols of aspiration towards higher things.

The tempo of innovation, when measured against the span of human life, was one of the reasons for present fear. "We wring our hands over the miscarriages of technology and take its benefactions for granted. We are dismayed by air pollution, but not proportionally cheered by, say, the virtual abolition of poliomyelitis. There is sense in which science and technology can be arraigned for new instruments of warfare, but another and more important sense in which it is the height of folly to blame the weapons for the crime."

"We can obviously do better," Medawar said. Only during the last centuries has there been progress, "but we cannot yet point to a single definite solution of any of the problems that confront us—political, economic, social or moral, having to do with the conduct of life. We are still beginners and for that reason, hope to improve." Quoting Hobbes's *Leviathan* Medawar said:

> "'Life itself is but motion, and can never be without desire, or without fear, no more than without sense; there can be no contentment but in proceeding'. I agree", Medawar said in his address.

I concurred completely with Medawar and therefore published his outstanding logical analysis of human fears and hopes. He was not only a prominent scientist, but also an eminent scholar and philosopher and his death, 18 years later in 1987, was a great tragedy. [See titles 186 and 186 A]

*This is a continuation of the basic diagram of **Title 164**, setting out the *Shared Characteristics of a large scale Enterprise**

The total cost of the Apollo Program $ 21349 million, was broken down into Spacecraft $ 6939 million, Saturn vehicle $ 7940 million, rocket engine development $ 854 million, tracking and data acquisition $ 541 million, and Manned Space Flight Center operations $ 2128 million; the remainder being accounted for as facilities and general operations.

Also most interesting was the method adopted by NASA to select one out of five competing industrial companies for one major component, here the Apollo Spacecraft itself. Each competitor was rated, on a 0 to 10 basis, for technical approach (30%), technical qualification (30%) and business management (40%); the summary rating for the Martin Company, 6.9, was decisive for the award of the contract.

Two possible applications of the Apollo Management Lessons concluded Seamans' and Ordway's masterly analysis. One was 'Project Mohole', to drill into the Earth's crust where it was thinnest, namely under the Ocean. Although the structure was never built, the *Glomar Challenger* ship which later carried out part of the program, benefited much from the previous design work.

The second application was directed to regain for the USA the energy self-sufficiency which it once enjoyed. An underwater electricity generating station was envisaged based on the Rankine power cycle using the 20 °C temperature difference between deep and surface water temperatures in the tropics. A huge barge was constructed, but the project was never finalised.

My Perfect Secretary and my Perfect Book Restorer Title 274

Looking through my diary of 1977, I seem to have had an extremely busy and pleasant time. In London, appointment followed appointment with scientists to invite them to contribute to ISR, interspersed with visits to Heyden in Hendon in north London, regular meetings with my secretary Mrs Lyons, not far away from Hendon, and of course personal friends.

Mrs Ethel Lyons was my faithful aid and assistant throughout the 22 years I edited ISR. She was a perfect shorthand writer and typist. I visited her, and during an average week, about 30 letters went out, which I had dictated during my visit to her home and mailed the following week after signing. She had been for many years Secretary to the Chairman of Marks + Spencer, Marcus Sieff, later Lord Sieff, who had trained her mercilessly to perfection.

When I was away from London, I was able to dictate letters before leaving, signed 30 blank sheets of notepaper, and utterly relied on her to mail absolutely faultless letters. I can never be grateful enough for her help and after a few years, she provided a room in her house as an office for ISR and for me. All the publishers paid was a pittance in cash. In many ways she was old-fashioned, no PC and it was always 'Dr Michaelis' and 'Mrs Lyons' between us, in spite of several decades of closely working together.

My best friend during the years after my 60th birthday in 1976, was Frank Sondheimer, Professor of Chemistry at University College, London and a Fellow of the Royal Society. We frequently met for lunch at Bertorelli, an excellent Italian restaurant in Soho, where we talked about collecting old scientific books, a favourite pastime for us both, about world politics and anything else that seemed topical to us. Occasionally I also met his American wife Betty, and his step-daughter who tragically died of cancer. Typically of Frank, as soon as the diagnosis was made, he rushed to the medical library of his College, and read all available literature

Another common interest which I had with Frank was the book binding and book restoration work for both our collections which Mr Bernard Middleton FSA carried out to perfection. His workshop was in Clapham, and there, with the help of his wife and only one assistant, he had achieved a world reputation, been elected to the Society of Antiquaries, had written learned books about his craft and had examples of his work on permanent exhibition in the British Museum. He was regularly invited to the United States to lecture, and both Frank and I had many superbly bound books in our collections, due to his devotion and skill. He beautifully and uniformly bound the complete set of the 21 volumes of my collected volumes of I S R which I had edited. In 2000 the British Library published *Recollections, A Life in Bookbinding* by Bernard Middleton, a delightful record by a master of his important art form.

Although I did not travel in *Daily Telegraph* style, I could not complain. Two visits to the USA, one to the AAAS in Denver and one to San Francisco and Alaska, were good, exciting and most useful inviting contributions to ISR. In addition there was a short hop to Paris, to the biannual Air Show at Le Bourget, one to Ludwigshafen to BASF, and to Bristol to attend the annual meeting of the British Association. All were combined with paying visits to Members of the Editorial Board. Altogether, several tens of thousands of kilometers.

During my first USA visit I went south from Denver to Houston, Texas, San Diego and Los Angeles in California. During those three weeks I called on Harold Urey, and saw him for the last time as he was already weak and ailing. I was always happy to meet him, so gentle, so knowledgeable, and so kind in discussing my difficulties as an Editor. Whenever I had to leave him after a short lunch, I always wished he lived in England and would be more readily accessible for discussions. I also saw Marteen Schmidt, the great astronomer in Pasadena at Caltec, who had discovered the furthest stars in the Universe through his measurement of the redshift of their light waves.

My second journey to the USA was at the invitation of ICUS [see below] and British Petroleum, BP, to come to Alaska and write about their part in the construction of the Trans-Alaska Pipeline. I invited several of their leading engineers to contribute, but regrettably nothing ever came of it. Nevertheless I saw another part of the exploitation of the Arctic oil resources, this time in the American part, in addition to what I had seen in the Canadian Arctic. I flew to Washington as usual and there I called on Hans Mark, a Member of my Board, before travelling west again.

Hans Mark, who at the age of 3 years had come from Mannheim, Germany, to the USA, with his famous father, the famous polymer chemist, had become a great physicist, a most skilful administrator and after having been the Director of NASA's Ames extensive Research Center, had by the time of my visit in 1977 been called to the illustrious appointment of Secretary of the United States Air Force. I visited him in the Pentagon, a very impressive journey along endless corridors guided by friendly escorts, until I reached the largest office I ever saw in my life. There between two large flags, one of the Air Force, the other of the United States, stood a gargantuan rectangular desk behind which Hans, a large man by any measure, looked small and was almost hidden. It was one of his last days in office, as he was a Democrat, and the new Republican Administration of President Reagan had naturally demanded his resignation. We were on first name terms by then, had a very friendly talk and I promised to visit him in his next appointment as Chancellor of the University of Texas System in Austin, which I did. [See Title 351]

The 'Moonies' and the Alaska Pipeline Title 276

On the recommendation of Professor Nicholas Kurti FRS of Oxford University, a world expert in cryogenics and a Member of my Editorial Board, I received an invitation to the 'International Conference on the Unity of Science', ICUS, to be held in San Francisco at the end of November 1977. I soon learnt that the organiser was none other than the Rev. Sun Myung Moon, the Korean Evangelist who had in 1954 founded the Unification Church. By 1977 he and his church had a somewhat doubtful reputation, as he was accused of indoctrinating children and enticing them away from their parents to his harsh educational camps. Further more his industrial empire was much involved in arms manufacture and the sale of the 'miracle' tea Ginseng.

Was I to accept a free trip to San Francisco, which I had never seen before, and participate in discussions about the 'Unity of Science'—whatever this meant—or be solely guided by rumours about his doubtful reputation and refuse to attend? I decided that Kurti's acceptance and my natural curiosity about the Reverend Moon himself, allowed me to accept. Incidentally in 1984 Moon was imprisoned in the USA for tax evasion.

The Conference was held in two Hotels, the Fairmont and another, with about one thousand people attending, among them Paul Wigner, the Hungarian born nuclear physicist, a Nobel Laureate. All was conceived and arranged in great luxury with lavish evening entertainment by Korean dancers, but of science, let alone its 'unity', there was little to be heard in the many lectures and informal discussions. Nothing reached the high scholarly standard of ISR contributions, and I therefore decided not to invite any articles for publication.

With my invitation by British Petroleum, BP, to come to Alaska in my pocket, I was not sad to leave San Francisco and fly north to Anchorage and then to Fairbanks, where I met an old Australian friend Keith Mathers at the University. He introduced me to his colleagues who had contributed to ISR 2/3. Back to Anchorage and from there, in the good hands of BP, flying in a private plane to Prudhoe Bay, 70° north, to Drill Site Number 1. My watercolour sketches made on the site show it as a totally enclosed grey structure, in grey snow and with a grey sky.

Yet Prudhoe Bay is the beginning of the 1200 km long Trans-Alaska Pipeline, pale blue in its protective covers. A BP car took me from Prudhoe Bay along the service road, often parallel to the Pipeline, to the Valdez end, where it ended in huge storage tanks before being loaded on to tankers taking the oil south. The road was breathtakingly beautiful, as we drove past snow—covered mountains like Mount Sandford, 4952 m, and on, over the Thompson Pass. We stopped occasionally at the pipe's pumping stations, where the oil was heated to reduce its viscosity so that it could easily flow again. But sadly, no article!

See Watercolour Title 276, inside Back Cover

SITE, the Satellite Instructional Television Experiment, began on 1 August 1975 and ended one year later, 31 July 1976. For me this 'experiment' represented one of the most significant results of the American space effort, as it showed the highly effective scientific attempt to reduce the population explosion by cheap instruction to rural populations of the Third World. So far, it has regrettably never been repeated anywhere else. I published a description of it in January 1978 and of the first positive results achieved. The author was Professor Yash Pal, the Director of the Space Application Centre, Ahmedabad, India. Perhaps one of the best examples of the Scientific Temper, I can quote.

During several visits to India I had met him and heard of SITE. Yash Pal had received his PhD from MIT Cambridge, Mass. and was therefore conversant with space science and space technology when, after his Professorial appointment at the famous Tata Institute in New Delhi, he was appointed Director of India's foremost space research center, most likely by Nehru himself. We had often talked about SITE, and after my repeated invitations, I finally received his manuscript in London on 1 November 1977. The satellite used for the experiment was NASA's ATS-6, launched May 1974.

Video tapes were prepared by All India Radio/Doordarshan in Delhi, transferred to the Ahmedabad Centre and beamed from its ground station to the Satellite. The programes achieved considerable progress in the areas of information, awareness and knowledge of health and hygiene, political consciousness, overall contemporary thinking and family planning. In addition 50000 rural teachers were enrolled during the experiment in a multimedia package, training them in the teaching of mathematics and general science.

The simple community television sets and the efficiency of their maintenance was sufficient to keep 90 % of the sets working at any time at a picture quality better than the normal VHF receivers in Indian cities. One and a half hours of broadcasting in the morning was devoted to school children and 2½ hours in the evening to general audiences, which averaged 100 people per set. From the total of 2400 villages in six states receiving the programes, 27 were chosen for continuous analysis, with 270 interviews per day.

Yash Pal reported that the experiment was an exhilarating experience for all, that the benefits were greater for 'the underprivileged classes, such as females and illiterates', and that these gains increased as viewings multiplied. Case histories of farmers showed that innovations were adopted, provided that no additional expense was involved. Altogether, female audiences were keenest and learnt most, as several statistical analyses showed.

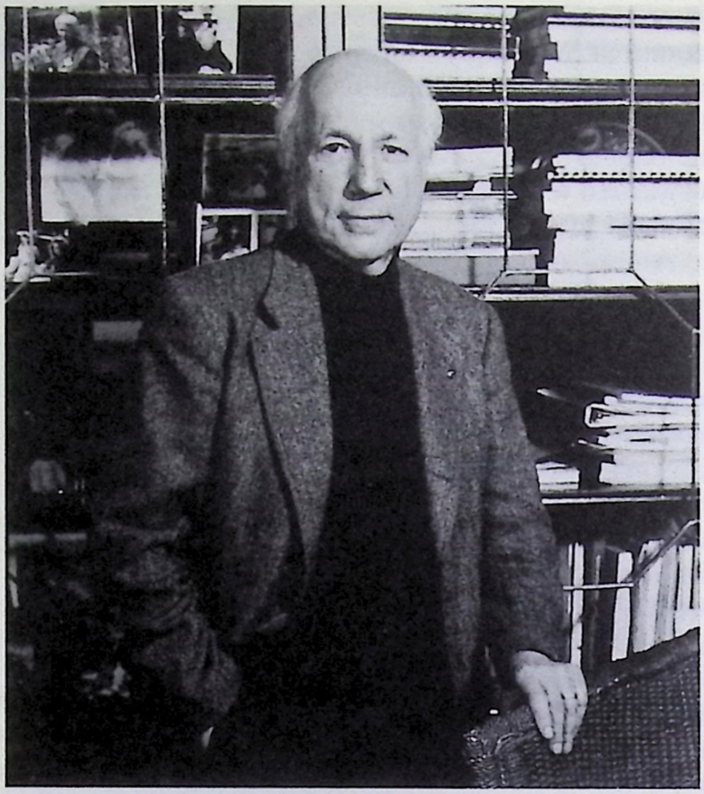
In 1826, an English chemist, James Smithson FRS, made a will leaving a residual bequest of £ 104960 8s 7d "to found at Washington under the name of Smithsonian Institution an establishment for the increase and diffusion of knowledge among men". After Smithson's death at Genoa in 1829 and some legal arguments in English courts, the principal of the bequest was converted into English gold Sovereign coins, and as ship's ballast, forwarded to Philadelphia where it arrived in 1838. As at the time the local Mint was short of gold metal, the first use of the bequest was to convert it immediately into American Gold coinage.

To this day it is quite unknown why Smithson desired the then 'small wooden-hutted village in a swamp', now the Capital of the United States of America, to benefit in his will. I tried in vain to solve this mystery, but my researches only reached a certain point when I discovered that the Swiss-born great American naturalist of Harvard University, Louis Agassiz (1807-1873) stated in evidence to Congress that he knew the reasons for Smithson's bequest. May a future enthusiastic researcher be more fortunate and follow up this clue.

The ISR article was published in June 1978 and contributed by S. Dillon Ripley, a Member of my Editorial Board, in fact the eighth Secretary of the Smithsonian Institution. In his article he traced the Institution's history and described the difficulties which Congress had in the 1830s to decide how best to use the money with only the cryptic instructions from the benefactor. It was Joseph Henry, the eminent physicist, who in 1846 became the first Secretary and who defined for all times the future function of the Institution.

Ripley reviewed his seven predecessors and their work and concluded with a statement of his own philosophy. An appendix listed the Bureaux of the Smithsonian; their names alone are full testimony of how magnificently the instructions of Smithson "the increase and diffusion of knowledge" had been fulfilled, during the century and a half since his death.

The Bureaux are: National Museum of Natural History; National Museum of History and Technology; Smithsonian Astrophysical Observatory; National Zoological Park; National Collection of Fine Arts; Renwick Gallery; Freer Gallery of Art; Smithsonian Tropical Research Institute; National Air and Space Museum; National Portrait Gallery; Radiation Biology Laboratory; Anacosta Neighbourhood Museum; Cooper-Hewitt Museum of Decorative Arts and Design; Joseph H. Hirshhorn Museum and Sculpture Garden; Archives of American Art. The Appendix was contributed by J.A. Steed, Archivist of the Smithsonian Institution.



Title 279

Melvin Calvin For. Mem. RS, Nobel Laureate 1961, was a Member of the ISR Editorial Board from 1978 until he died in 1997. He was Professor of Chemistry at the University of California, Berkeley, where I visited him. He received the National Medal of Science from President Bush in October 1989. For his pioneering work on photosynthesis using carbon 14, he had received the Nobel Prize 28 years earlier, elucidating the many steps of carbon during photosynthesis, now called the 'Calvin Cycle' in his honour. *Courtesy UC Berkeley.*

This was the first issue of ISR almost entirely devoted to a single subject and published in September 1978. It was suggested by Dr Tom Lambo, a Nigerian and the Deputy Director-General of the World Health Organisation, as well as a Member of my Editorial Board. I had visited him in Geneva, discussed the idea with him and invited a number of his colleagues to contribute.

As usual, I wrote the first Editorial, attacking an often quoted statement that 'small is beautiful and multinational is bad' in relation to World Health. As far as I knew, the first precept had never been applied to the size of the medical research effort, and as far as drugs were concerned, those produced by multinational companies had never been selectively refused by any patient. An organised attack on global trade and industry came only in 1999 in Seattle.

My editorial was followed by Dr Halfdan Mahler's, the Director-General of WHO, writing about "World Health is Indivisible". He outlined a blueprint as 'the unusual step of appealing directly to the political leaders of the world' as he put it. He pleaded for primary health care, giving priority to proper nutrition, safe drinking water, a healthy environment and the eradication of communicable diseases, particularly in the developing countries.

The main contributions were varied in contents and ranged widely from good health communications, water supply, research on birth control technology and the new mental health programme of WHO, to chemicals and health, ecology and vector control, research and training in tropical diseases, cardiovascular diseases and finally the role of WHO in international drug control. Each article was written by the WHO expert responsible for the subject and the whole issue thus represented a very authoritative and international contribution, abstracting the most up-to-date state of nearly all medical knowledge.

Another important article in this issue was concerned with "Chemistry, Population, Resources" by Melvin Calvin of Berkeley, a Member of my Board and a Nobel Laureate, who pleaded that the growing of hydrocarbon producing plants in arid or semi-arid regions, where they would not compete with food production, could produce chemical energy, only slightly more expensive than fossil energy from oil. The subject of photosynthesis as a renewable energy source had been his main research subject for over 20 years.

The last page of the issue was a tribute to "Sir Humphry Davy—Poet" celebrating in 1978 the Bicentenary of his birth. Sir George Porter, also a member of the Board and a Nobel Laureate, had arranged a Symposium for this purpose at the Royal Institution, and he quoted two poems in his short contribution.

The centenary of Einstein's birth in 1879 would obviously be celebrated in academic and Jewish communities all over the world, and I was anxious to pay an interdisciplinary tribute. I had a number of Einstein medals in my collection [See Title 74] and thought I would reproduce these in the memorial issue in December 1978. But why not also paintings, drawings and sculptures of Einstein, if I could find them, on other pages of this Issue of the Journal?

My own Editorial recalled a few anecdotes how Einstein reacted to being so often portrayed, and I added pictures of three medals. Edward Teller's editorial comment *Unconventional thoughts about an unconventional man* followed. I illustrated it with a cartoon by David Low, showing Einstein dancing over his own shadow.

The two major articles were by Max Born "In Memory of Einstein" and by W.H. McCrea "Albert Einstein, Physicist". I was able to illustrate a different picture of Einstein on each page. These reproductions were:

Oil Painting by Max Liebermann at the Royal Society, London
Oil Painting by Nikolas Schattenstein at the Hebrew University, Jerusalem
Tempera Painting by Hans Erni, Erni Trust, Lucerne
Ink Drawing by Peter Blake, Lefevre Gallery, London
Oil Painting by Eugen Spiro, Princeton

Oil on Burlap by Joseph Scharl, National Portrait Gallery, Washington
Painting by Leonid Pasternak, Hebrew University, Jerusalem
Etching by John Phillipp, Colnaghi's, London
Etching and drypoint by Julius C. Turner, National Portrait Gallery, Washington
Drawing by an unknown artist, Hebrew University, Jerusalem

Etching by Hermann Struck, Archives of Cal Tec, California
Charcoal Sketch by Eugen Spiro, Mrs Spiro, New York
Ink drawing by Ludwig Scharl, Gallery Nierendorf, Berlin
Mosaic by Elsa Schmidt, Rye, New York
Bronze bust by Jacob Epstein, Weizmann Institute, Rehovot, Israel

Bronze bust by Eleanor Platt, Physics Division, Cal Tec, California
Bronze bust by Hermann Hubacher, Aargauer Kunsthaus, Switzerland
Bronze bust by Jacob Epstein, (different version) Sotheby's, London
Bronze bust by Robert Berks, Weizmann Institute, Rehovot, Israel
Bronze bust by Hermann Hubacher (different version) Fritz-Haber Institute, Berlin

Bronze bust by Doreen Anziska, Weizmann Institute, Rehovot, Israel
Bronze plaquette by Sturm van der Bergh, Hebrew University, Jerusalem
Marble bust by Fiedler, Deutsches Museum, Munich
Glass sculpture by Paul Schulze, National Air and Space Museum, Washington

After publication I was told that Joan M.N. Warnow had written *Images of Einstein a Catalogue*, published by the American Institute of Physics in 1979. I never saw it but wondered what, if any, duplication existed!

DC 10 Crash—Geoffrey and Heather Brigstocke   Title 281

Geoffrey Brigstocke had been a very good friend since our student days before World War II, he at Magdalene College, Cambridge and I at Imperial College, London. After his period as a prisoner of war, and my internment in Canada, we saw each other again frequently in postwar London. Geoffrey had become a high civil servant in the Ministry of Transport, and in March 1974 he had attended, as official British representative, a meeting in Moscow. Flying home he reached Paris, where he was forced to disembark from his BEA flight, as the ground engineers at Heathrow, London, had gone on strike.

He must have thought himself lucky to be allocated a seat on a London bound flight of the Turkish airline, THY Flight 981, a DC-10 aircraft, made by McDonnell Douglas. On Sunday, 3 March 1974 the flight took off from Paris Orly at 11.11 GMT and crashed 11 minutes later, all 346 passengers perishing.

The reason for the crash was soon established; as the rear cargo door had been insufficiently locked, it flew open, and the cargo compartment was therefore decompressed. The air pressure in the passenger compartment above the cargo was strong enough to fracture the weak floor between the two compartments. The control links between the cockpit and the rear control surfaces were embedded in this floor, the links broke, the aircraft became uncontrollable and dived steeply to the ground.

Stanley Stewart in his *Air Disasters*, Arrow Books 1986, fully analysed the previous history of the rear cargo door of the DC-10, which had already failed on numerous previous occasions. Owing to many political, administrative and technical mistakes in the USA, the closing mechanism had never been properly corrected. On the fateful day at Orly, an Algerian mechanic, unable to read the English warning instructions on the door, once again failed to close it correctly.

Geoffrey was by this time married to Heather, who had naturally also become a very good friend. As gifted as Geoffrey, her career as a school teacher, Head Mistress and as High Mistress of the famous and fashionable St. Paul's Girls' School, had been as rapid as her husband's. Since Geoffrey's tragic death, I saw her as often as possible, we talked a lot about him and I was able to tell her of his Cambridge days. Heather of course had many other friends and later, when she was created Baroness Brigstocke, and thus a member of the House of Lords, our meetings became a little less frequent. Many years later she married again, Lord Griffiths, the well-known Judge.

Heather joined the Editorial Board of ISR and graciously hosted two of its Dinners, at St Paul's Girls' School in 1988 and at the House of Lords in 1992. On many a happy Christmas, Heather and her children became my family.

All my travels during 1978 had become routine. I attended the American Association in New York in February, the Lindau Meeting of Nobel Laureates in July, the British Association in Bath in September and the German Gesellschaft in Freiburg in October. On all these occasions I had a chance of inviting eminent scientists to contribute to ISR, and although they were all impressed when I showed them my Journal, and most of them promised to write, the total response to my endeavours was about one third.

For the actual manuscripts I often had to wait many months, if not years, provided I reminded the potential authors often enough. I was happy with this low percentage, as it allowed me to invite many, and with some luck I soon accumulated enough 'capital' of articles. Whenever I had to prepare a new issue, four times a year, I was always able to create from my capital either a theme of similar subjects, or a contrasting collection of contributions.

As I could invite so many authors, and wait for their initial acceptance and final delivery of the manuscript, I was able to acquire many friends among those who lectured at the Associations. They were always pleased to be asked to help a new and promising Journal with their own subjects, and as I had nearly always heard their lectures I could judge if they were scholarly and interdisciplinary. If not, I walked out; there were usually alternatives at the American and the British Association Meetings. Or I fell asleep.

I was always amazed that these eminent scientists, who had been so carefully selected by the Associations, never gave a thought to the publication of their labours. They had been invited many months beforehand, they had devoted a great deal of time to write, and even more effort to collect together the necessary illustrations, not infrequently borrowed from colleagues in a different continent.

But publishing had only rarely entered their consideration. My regular visits to these Meetings and my many invitations may make my methodology appear haphazard, but it worked perfectly satisfactorily, at least for a quarterly Journal. I required about 24 major articles a year, about 16 Editorial Comments, as well as about 20 book reviews for each annual volume.

I could point to the basic definition of interdisciplinary articles as set out in the first issue, and if ever there was any doubt, the simple decision to invite a contribution was totally in my hands. There was no need for me to consult anyone else, if I had heard the lecture or if the author held a professorial appointment at a recognised university. But modified refereeing [Title 283] took place when I thought it was necessary. This occurred fewer and fewer times, as I gained more experience during the 20 years I edited ISR.

Even before the appearance of the first issue of ISR, Peter Farago and I had decided that only a very high standard of contributions would be acceptable. This was of course easy to achieve if the author was personally known to us, or if either of us had read his publications, but that was not always a sufficient guarantee that he could also write for a wide scientific readership which was our aim. At the beginning we could not show any sample issues of ISR as a guide, and if we had adopted the standard lengthy refereeing system, first publication might have had to be delayed for a year or so.

We therefore invented what we called 'A Modified Referee System'. We asked the prospective author to submit to the Editor a Synopsis of 500 words of his proposed contribution. We argued correctly, as it turned out time and time again, that if an author could write 500 words clearly and convincingly, he would be able to do the same for an article in 5000 words, the average length of the major contributions. It is well known that it is far easier to write at great length, than a short précis, and that it demands a thorough knowledge of a subject to decide what to include and what to leave out.

Having received a synopsis of 500 words, it was always easy for me to decide to which Member of the Editorial Board I should submit it for his or her comments. To read 500 words is no great task for anyone, however many other demands on his time await him. I always duplicated any synopsis received and sent it to five Members of the Board, and only rarely did I have to follow the majority verdict or exercise my final Editorial authority.

As the title of the Journal was relatively novel, and it was at the beginning quite unknown, there was no stream of articles flooding the Editor's office. In fact during the 20 years of my work for ISR, the number of unsolicited articles was very small, and if it did occur, the modified referee system provided an easy check on an unknown author's standing.

I never had any complaints from Members of my Board that the task of reading and commenting on 500 words was onerous or difficult. Of course with 60 to 70 Members from which to choose, the need to request their comments on a synopsis might occur perhaps once every two years, really no great chore. It was their only duty, I explained, when inviting a new Member to join the Board, and in return they received a free subscription to the Journal and an invitation to an annual dinner. I always tried to make it a festive, rather than a formal occasion. These dinners were held either at an Oxford or Cambridge College of a Member of the Board, at my Club, the Savile in London, one in the USA at the Cosmos Club, Washington, and one at the House of Lords. [See Title 350]

ISR 4/1 *Interdisciplinary Science Policy* Title 284

Derek de Solla Price pointed out the "Exponential Growth of Science" first in 1951 and repeated it subsequently on many occasions [see Title 403 and *Discovery* 1956, p. 240 and ISR 1996, p. 64]. With this novel concept he started a world wide discussion on how this growth of science might be directed, upwards or even downwards, and thus the subject of 'science policy' came into being. For me it was guided by my Scientific Temper.

To my mind 'science policy' should be interdisciplinary. "Separately, neither Cabinet Ministers nor Nobel Prize Winners can any longer solve the problems of the world", as I stated in the first sentence of my Editorial of this Issue, which was completely devoted to Science Policy in its widest sense.

Introducing this unique discussion, published in ISR in January 1979, were the then President of the Federal Republic of Germany, Walter Scheel and Professor Dr Reimar Lüst, the President of the Max-Planck-Society. A dissenting view came from the Right Honourable Anthony Wedgwood Benn P.C., M.P., pleading for freedom of information to preserve democracy in the age of science and also from Professor J.L.M. Morrison, one of England's foremost engineers, strongly criticising the rust on the engine of society.

From the Office of Technology Assessment of the United States Congress, J.F. Coates presented a critical and brilliant analysis of the issues facing public policy makers, not only in his country, but everywhere in the world. Dr Alexander King, co-founder and later President of the Club of Rome, reviewed the international and interdisciplinary *problématique* of the world, Professor H. Mohr stressed the 'ethics of science' and Dr A. Kantrowitz pleaded for the establishment of a 'Science Court' to control technology.

Psychological operations to persuade friends or enemies, including psychological warfare, were the subject of the last review by Dr Preston S. Abbott and his colleagues. As a scientific technique to enforce policy, consciously or subconsciously, it was all too often employed in war, in political and scientific debates and is still highly controversial, but certainly interdisciplinary.

To this important issue of ISR, I was able to contribute a number of historical illustrations, such as a picture of the young Alexander von Humboldt, 'The gentlemen of the press' in the reporters room of the House of Commons in 1882, a portrait of Benjamin Franklin, an illustration of the 'Test Tube Baby' by A. Robida of 1883, an artist's impression (1870) of a Meeting of the Lunar Society, and finally a drawing of the opening meeting of the British Association in Newcastle in 1863. It was a much acclaimed issue.

Professor S.A. (Tony) Barnett was Head of the Zoology Department of the Australian National University in Canberra. He became a good friend during my many visits to Australia, and I was glad when he joined my Editorial Board. He reviewed a good number of biological books for the Journal, and his wide interdisciplinary knowledge of his subject was a great help to me. His special field of research was animal behaviour, and in a fundamental article which he called *Co-operation, Conflict, Crowding and Stress: An Essay on Method* he criticised the unscientific comparison between unrelated animal and human behaviour. Here follows an extract of the abstract he wrote for the Article, published in June 1979.

> The science of animal behaviour is still evolving from its pre-scientific past. It rests on exact description, but is an experimental discipline. In Wittgenstein's phrase "conceptual confusion' remains." Analysing the concepts of altruism, crowding, dominance, stress and territory, Barnett tried to replace the illusion that ethology can solve human problems, with a statement of what ethology can do.
>
> Social ethology, analysing the species-typical signals of animals, can provide methods for studying human non-verbal communications in infancy. But human languages are argumentative and superior by several orders of magnitude.
>
> The concepts of territory and of dominance as well as subordination have been valuable in the study of animals, but they are of little use in the analysis of human societies.
>
> Man is uniquely versatile and has no single habitat or mode. Hence the human species must fall outside any analysis in which habitat and species-typical conduct are related.

"Current fashionable comparisons of man with other species reflect the prejudices of the writers, and have no scientific validity"—Barnett wrote. "The notion that men are ineradicably violent among themselves is a version of a pessimistic outlook which has been repeatedly expressed throughout history. Biological findings have been used, unjustifiably, to support this view and its opposite. The concept of innate behaviour, and of genetically fixed patterns of conduct, is being replaced by an epigenetic interpretation, namely: Behaviour, like other features, is a product of an ontogeny in which genotype and environment interact.

"Human diversity creates immense problems for man, but also provides means of solving them by conscious, voluntary action" Barnett concluded.

I decided to celebrate 'Ten Years after Man's first landing on the Moon' by an issue entirely devoted to space. I had collected the most appropriate contributions for some time and was able to arrange with Rockwell International that copies of this issue of the Journal were distributed free of charge to anyone who wished to receive it. A special band, stating this fact, was printed and it was bound round each copy of the Journal, published in September 1979. Many extras had to be printed.

The following authors contributed:

G.B. Gresford	United Nations Conference on Science and Technology
M.A. Michaud	The Extraterrestrial Paradigm: Improving the Prospects for Life in the Universe
B.T. O'Leary	Space Manufacturing, Satellite Power and Human Exploration
G.W. Jeffs	The Space Shuttle: Its Interdisciplinary Design and Construction
F. el-Baz	Scientific Exploration of the Moon
R. Suter	A Fountain of the Moon at Basle

My own Editorial with the title *Space—An Alternative to War* was based on my conviction that, if the daily, world-wide war expenditure of $ 1500 million, [a 1979 estimate], was spent on various space activities, it would not only lessen the risk of World War III, but would also benefit the shareholders of the military-industrial complex. As a high technology industry, the production and sale of armaments provides considerable profits, as well as full employment for skilled workmen, research scientists and engineers.

Instead of *Si vis pacem, para bellum*, the requirements of constantly advancing space technology provides a far greater challenge than developing old armaments for new wars. For Lunar Cities or Manned Mars Exploration, progress in ever smaller micro-electronics, advanced new materials, stress analysis of astronauts and space nutrition, to mention only a few, will demand human invention and ingenuity of the highest possible degree.

The products of the armaments industry are generally high cost items, short lived and non-productive, and when outdated are often unloaded to other countries, lower in the technical-military hierarchy. Although military satellites and spacecraft cannot be resold, they equal armaments in the three qualities of high cost, short life and being unproductive. So far the advocates of the military-industrial complex have been more powerful and eloquent than the spokesmen for space, and I regretted this discrepancy in my Editorial of 1979, just as I do now, decades later. It is a total absence of the Scientific Temper.

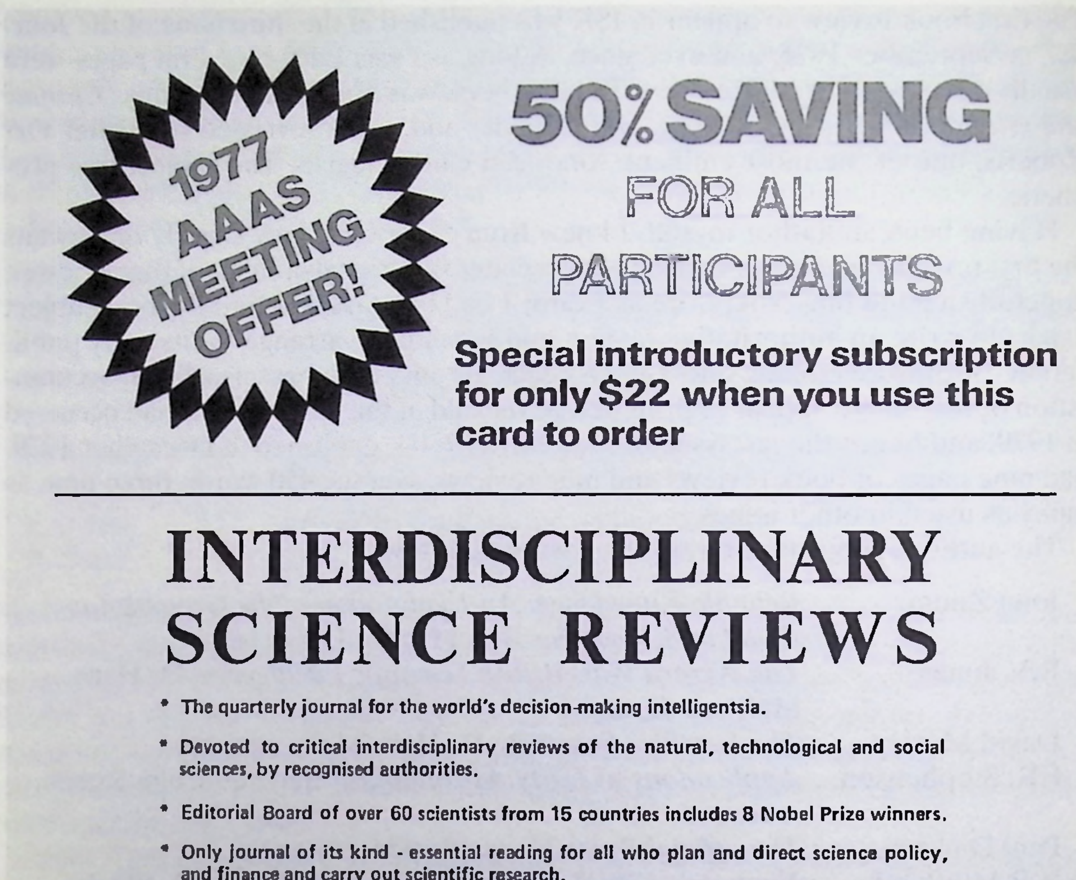
The first book review to appear in ISR was published in the third issue of the Journal, in September 1976, and ever since, as long as I was Editor, several pages were usually devoted to Book Reviews. The first book was *The Genesis Strategy: Climate and Global Survival* by Stephen H. Schneider and it was reviewed by Walter Orr Roberts, one of the most eminent American climatologists. The subject was prophetic.

Having been an author myself, I knew from experience how eagerly one awaits the first reviews, and how much one appreciates the critical opinion of the reviewer, hopefully a good one. Therefore as Editor I had two tasks: to find the best subject expert to write an authoritative review, and secondly to arrange for its early publication. Both were equally difficult, and each autumn there was usually an accumulation of reviews to appear in print before the end of the volume. This had occurred in 1979, and hence the last issue of the year, ISR 4/4, published in December 1979, had nine pages of book reviews and nine reviews, average 450 words, three time as many as usual in other issues.

The authors, subjects and reviewers were as follows:

John Ziman	*Reliable Knowledge: An Exploration of the Grounds for Belief in Science.* Sir Brian Pippard, reviewer.
R.V. Jones	*The Wizard War: British Scientific Intelligence.* Dr Hans Mark, reviewer
David Morley	*The Sensitive Scientists.* Dr Hans Mohr, reviewer
F.R. Stephenson	*Applications of Early Astronomical Records.* Colin Ronan, reviewer
Paul Dickson	*The official Rules.* Denys Parson, reviewer
R.P. Multhauf	*Neptune's Gift: A History of Common Salt.* M.R. Bloch, reviewer
Peter Watson	*War on the Mind. The Military Uses and Abuses of Psychology.* P.S. Abbott and M.M. Houston, reviewers
Colin Ronan	*The shorter Science and Civilisation in China I.* Trevor Williams, reviewer
Nigel Calder	*Spaceships of the Mind.* Adrian Berry, reviewer.

The books were interdisciplinary and the subjects wide-ranging indeed. Lack of space prevents a discussion of the interesting subjects in each case, nor can I give the qualifications of each of the eminent reviewers. Dr Hans Mark, for example, a nuclear physicist, was at the time Secretary of the US Air Force and undoubtedly fully conversant with all aspects of scientific intelligence, and had perhaps even discussed the subject of the book with the author.



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Title 288

This leaflet was widely distributed by me at the Meeting of the **AAAS in Denver** and a similar one with a German text at the Meeting of the **Gesellschaft Deutscher Naturforscher und Ärzte** in Stuttgart later in the same year. © *G. Heyden*

At the end of the third year of publication in 1979, it was obvious to Gunter Heyden, the publisher and to me, that the original optimistic hopes of 3000 subscribers had not been fulfilled. The estimated costs for the first year 1976 was £ 21000, but in fact they ran to £ 27000, with a loss of £ 18000. In 1977 the loss was smaller: £7000, but it increased again in 1978 to £ 8500. Comparing the costs of production with the size of the Journal, it had 354 pages in the first year, 344 in the second, and 348 in the third year.

The only noticeable reduction in production costs was in Authors' Fees from £3000 in the first year to £ 1000 in the third. This was due to the simple fact that the Journal had reached a high standard, and that prospective authors no longer had to be offered any fees, but were pleased to be invited to contribute without payment. The overall situation was by no means satisfactory, in spite of superb advertising by the publisher.

For the first issue, March 1976, a Press Release was issued and widely distributed, together with a four and a half page strident yellow prospectus, listing contents of ISR 1/l, the Members of the Editorial Board and titles of future articles. For the second year a six page "Anniversary Subscription Offer" was printed in two colours and the Journal offered for $ 22 a year, a reduction of 50%. The same 50% cut in subscription, namely £ 12.50 and DM 66.00, was available to British and German subscribers.

This pamphlet was widely distributed by me at the annual Meeting of the American Association for the Advancement of Science in Denver, Colorado. The same leaflet with a German text was handed out at the Meeting of the Gesellschaft Deutscher Naturforscher und Ärzte in Stuttgart. The last page of the pamphlet contained the contents of the First Volume, no better promotional publicity for a new scientific Journal could be imagined.

For my visit to Denver, Heyden generously put at my disposal 1000 copies of a new ISR Brochure, 100 copies of ISR 1/3 and 100 copies of ISR 1/4, as well as 200 copies of the Index for Volume 1. This annual Index, which I always prepared myself, had an alphabetic author and an alphabetic subject Index and thus represented an excellent prospectus for the whole Journal. Normally this Index is part of the December issue and its preparation was always a complex and time-consuming task which I started early in the autumn when page proofs of the December issue became available. My method was to highlight the relevant subject words in the four issues and then type cards for each. These could easily be sorted alphabetically on a big table and the cards sent to the printer. For many years I had the pleasant and highly efficient help of Ann Ronan in the preparation of the annual Index, and I retain a most greatful memory of our joint work.

For the many leaflets and brochures which Gunter Heyden and I prepared, we worked closely together, he drafting some of these and I the others. His life-long experience of publishing and the selling of scientific publications was for me a novel and priceless gift which he placed loyally at the disposal of his newest and my most valued asset, *Interdisciplinary Science Reviews.* One of these drafts, which I called a 'Blurb', summarises the reasons for our confidence, and we placed it on the back of the cover pages of each issue of Volumes 3 and 4:

INTERDISCIPLINARY SCIENCE REVIEWS ...

- was the first and is the only Journal entirely devoted to critical interdisciplinary reviews of all sciences, pure, applied, and social.
- is the quarterly Journal which has the highest academic standards. Contributions are by invitation only and each article is refereed by Members of the Editorial Board, including eight Nobel Laureates.
- is the Journal creating a new discipline, Interdisciplinary Science, essential for the solution of the great problems facing mankind
- is the Journal, which by its very nature, stimulates the interchange of ideas between diversely oriented minds because it publishes:
  Reviews about the border areas between two or more sciences
  Articles on the effects of science and technology on Society
  Contributions linking the sciences with the arts and the humanities
- is the Journal reputed for its excellence of presentation, for the breadth of its scope, its original choice of contents, the eminence of its contributors, and above all for its deep concern with the future progress of science for the benefit of all mankind.

This 'blurb' was first included in the January issue of volume 3, in 1979. The claims made for the Journal may sound exaggerated but, during the next 20 years, while I was Editor, I was told again and again how accurate and farsighted Heyden and I were when we stated them.

To quote only one confirmation from Lord Ashby FRS when he wrote in 1968 in his Foreword to *Interdisciplinary Thoughts I:* "500 authors, compelling evidence that the great issues in science are interdisciplinary and international. In the pages of *ISR* the Two Cultures have been bridged scores of times: science and history, science and art, science and music, science and politics". (This blurb was in fact an early statement of my *Scientific Temper).*

It must have been after five or ten years of sustained promotion to increase the circulation that a list of important subscribing Universities and Libraries was compiled. Among the 200 on the list were:

USA

Science Policy, Executive Office of the President, Washington
University of Hawaii
Los Alamos Scientific Laboratory
University of Chicago
Georgia Institute of Technology
Duke University, Durham
Cornell University
Lawrence Livermore Laboratory
Space Sciences, Berkeley
Institute of Advanced Studies, Princeton
National Academy of Sciences
National Bureau of Standards, Washington
National Library of Medicine, Bethesda MD
Naval Academy, Annapolis
Federal Bureau of Investigation, Washington

GREAT BRITAIN

Agricultural Research Council
The Royal Society, London
Jesus College, Cambridge
Shell Research, Sittingbourne
Unilever Research, Port Sunlight
I C I Millbank, London
The Ciba Foundation
I B M United Kingdom, London
Science Museum Library, London
Atomic Weapons Research Centre, Aldermaston

EUROPE

Scientific Affairs, N A T O, Brussels
Academy of Sciences, Stockholm
Niels Bohr Institute, Copenhagen
Hoechst AG, Frankfurt / Main
L'Ecole de Médecine, Geneva

REST OF THE WORLD

Jawaharlal Nehru University, New Delhi
Akademy Nauk, Moscow
Randse Afrikaans University, Johannesburg
Takushoka University, Bunkyo-Ku, Tokyo
Ibadan University, Nigeria

I began my Editorial by quoting Pope John Paul II. He stated "As hunger is the most serious danger to peace, food must be placed after human rights to a free life and security of the person". I continued that no human being, past, present or future, of whatever religion or race, can disagree with this statement. Neither could I write these lines, nor you read them, if we were hungry. I hoped that single cell proteins might produce an end to hunger, until the population expansion finally came to a sustainable level.

The most unusual interdisciplinary contribution of all I ever edited came from Professor Heinz Maier-Leibnitz: *Chairman and Cook—Twice as Spicy*. A distinguished physicist, he had been the President of the Deutsche Forschungsgemeinschaft and was a member of the Royal Swedish, the Austrian, the Finnish, French and Leopoldina Academies of Science. He invented an ingenious technique to accelerate and shorten his innumerable committee chairmanships, simultaneously pleasing the committee.

He wrote: "To ensure the appropriate decisions from a Committee, a novel but somewhat risky manoeuvre is recommended: The Chairman should be at the same time the Cook, preparing and serving a superb meal to bring the meeting to a speedy and successful conclusion. Theoretical considerations are followed in this article by a detailed description of a meeting-eating." I had on more than one occasion been invited by Maier-Leibnitz to a splendid lunch cooked by himself—an honour considered in Germany only slightly below the election to the Order Pour le Mérite, of which he was then the Chancellor.

Equally unusual was another article in the Special Issue published in January 1980 devoted to 'Biotechnology and Nutrition', by L. Narodny *Smell: A Challenge to Interdisciplinary Science*. He wrote that smell remains an intractable scientific problem, without its primary odours, or any periodic table of scents, and there are no satisfactory methods of measurements. Existing theories were reviewed, and perfumes of great value to commerce described. Human pheromones may exist and reveal an unsuspected communication system, and a millennium of research in molecular biology is wide open.

Other contributions were devoted to *Aquaculture, a critical assessment of its Future*; *The Biotechnology of Algaculture*; and *Enology: Science and Technology improve an ancient Art* by Professor A.D. Webb, the Head of the Department of Viticulture of the University of California at Davis. "Since the pioneering days of Louis Pasteur" he wrote "science had made wines cheaper, better and more plentiful, but future research will improve them still further as production of wines spreads even more in Europe and in other countries on other Continents".

The title of my Editorial was *High Technology Accidents — Unpredictable and Inevitable*. To prove the truth of this claim, I analysed the accidents of the Apollo 13 Moon Flight and the Three-Mile-Island Nuclear Accident. In case of Apollo 13, it took two months (April-June 1970) to determine that testing and re-testing of one small component, a thermostat switch inside a liquid oxygen tank, led to its permanent welding together, thus causing an explosion. It was an accident which was totally unpredictable. This issue of ISR was published in June 1980.

That accidents are inevitable is only now slowly being realised. Nothing, but absolutely nothing, made by man is perfect and will therefore have inherent faults, in design, material or manufacture. In a low-technology, like the car-road system, the fatal accident rate is appalling, and familiarity with road deaths has certainly bred contempt. High technology has its rare, but spectacular accidents, like Apollo 13, Three-Mile-Island, (Chernobyl was still in the future, April 1986), DC-10 aircraft disasters [see Title 281] or historically the sinking of the Titanic in 1911 and the burning of the hydrogen- filled *Hindenburg* Zeppelin in 1937. Both were hailed as highest technology in their days.

The best that engineers can achieve in their striving for perfection is to gain sufficient experience, allow a large enough safety factor and provide a back-up system in case a vital component fails. And most important, where human guidance is involved, as in the control of spacecraft, aircraft and atomic reactors, to provide training for the operators in the prevention of accidents by frequent simulation exercises. Or if they do occur, to rehearse and master the necessary rescue and escape operations. Instrument-Systems of greatest reliability, simplicity and clarity are also an essential requirement; these were not available at the Three-Mile-Island reactor control station.

In the Kemeny Report (October 1979) on the Three-Mile-Island accident one reads: "Training did not adequately prepare the operators to cope with the accident". The cost of the accident was estimated as $ 1.5 thousand million, so it is obviously cheaper to train the operators better, and to provide modern computer control systems, as for example the hierarchical computer control philosophy developed at CERN for their Super Proton Synchroton.

I summarised the lessons to be learnt: Accidents will inevitably happen at nuclear power stations, as Chernobyl proved 6 years after I wrote my Editorial: Highly trained operators; the most modern and simplest computer control systems are mandatory. When an accident has happened, a highly efficient aid and rescue service, trained by frequent rehearsals of their tasks, must be on constant alert.

I attended the Meeting of the American Association for the Advancement of Science in San Francisco in January 1980 and listened to the Keynote address by Dr Simon Ramo, America's foremost engineer and industrialist. I was fortunate enough to publish his lecture in September 1980 in ISR. Dr Ramo, a co-founder of TRW Inc. [The R stands for Ramo in TRW] is a recipient of the National Medal of Science and was Chairman of the Executive Committee of TRW, Chairman of the President's Committee on Science and Technology, and a founder-member of the National Academy of Engineering. His views on American technology, though sad, could not have been more authoritative.

I had two opportunities to judge American technology in great depth and was deeply impressed by its strength and its achievements. The first opportunity arose when writing the ITU book *From Semaphore to Satellite* [see Title 69] when I travelled across the United States to study the history of its telecommunications. The second chance for me was to follow the whole of the Apollo Saga from the beginning to the end [see Titles 163 and 243]—no greater technological zenith was imaginable. To listen only ten years later to Dr Ramo's pessimistic account was sad indeed, but I agreed fully.

Dr Ramo concluded that the US position of science and technology was deteriorating and that in consequence unacceptable economic, social and political repercussions would arise in the following decade, the 1980s, not only in the USA, but the whole world. The reasons for the severe slip in technology, he found in inflation, wrong tax policies, too low an investment rate and over-regulation for which he blamed the US Government. Dr Ramo had not noticed any deterioration in the basic inventive talents of Americans.

He suggested as a realistic approach, that in the USA science and technology would serve the interests of society best, if both free enterprise and government participated jointly in this endeavour. The most effective results would be achieved if clearly defined roles most suitable for each area were assigned to the two sectors.

Dr Ramo was against a concentration on a list of most attractive possibilities of technological advances, but rather he pleaded for a focussing on the non-technological social-economic-political factors, the patterns of decision-making and government-private sector relations, which are the controlling parameters in America. He concluded with the wish that the USA make this a guiding policy for the 1980s, because then America would see the implementation of a much wider range of the right technological developments, as for example a synthetic fuel program.

I do not know if his no doubt excellent advice has been followed, as I have not visited the USA as frequently as I did previously.

ISR

Interdisciplinary Science Reviews

Reprinted without change in pagination from Volume 5, Number 4, December 1980

HEYDEN

Title 294

A special reprint was ordered of this important contribution.

"Rioting and bloodshed to oppose technological progress are nothing new". This was the opening sentence of my Editorial, for the issue published in December 1981, critically reviewing all possible technologies to dispose nuclear waste, such as indefimite storage in and under the earth, the ocean, or the ice of the Antarctic and in space, for example on the Moon. I cited the violent and bloody opposition of politicians and ecologists to the German site at Gorleben, where the abandoned Asse salt mine had been used for research and safe disposal of low and medium level radioactive wastes since 1965. German plans for a full scale industrial repository, the so-called *Entsorgungszentrum*, (a total disposal system) failed, because of political and environmental opposition. [See also Title 93, Atomophobia]

Guided and escorted by a very good friend I was able to visit the Asse Salt Mine on two occasions. Driving me in the special underground inspection car was Dr (now Professor) Carsten Salander, then the Head of the Department of Nuclear Power Plants of PreussenElektra, Germany's second largest electricity utility, and also in charge of the German Company for Reprocessing of Spent Nuclear Fuel, the DWK. I was much impressed by the thorough research approach and the care of depositing the thousands of drums containing the radioactive waste. Naturally I invited him to contribute an article to ISR.

A salt mine has many advantages for a very long term and safe acceptance of radioactive waste. Geological salt formations are extremely stable and persistent, due to the plasticity of rock salt under pressure from the overburden of geological strata. This prevents the access of ground water which could leach out radioactive compounds and return them to the biosphere. Furthermore, due to the geo-mechanical stability of rock salt, large cavities can be excavated and these remain firm and unchanged even without any man-made support. In addition the rock salt has excellent thermal conductivity and thus allows the dissipation of heat generated from high level wastes. The stability of the Asse mine was attested by its geological age, Permian, of more than 200 million years.

In I S R 5/4, published in December 1981, Salander and his two colleagues, Dr Proske and Dipl-Ing. Albrecht published a 12-page article on *The Asse Salt Mine—The World's only Test Facility for the Disposal of Radioactive Waste.* They described in detail the geology of the Asse, the salt mining activities in the Asse salt dome and the underground workings. They discussed the test disposals of low level, intermediate and high level wastes, the acceptance criteria, independent research, and the waste depositories within the envisaged *Entsorgungszentrum*. The article ended with a discussion of the opposition in Germany to all nuclear power, and the political actions needed for safe waste disposal.

Round the World in 90 Days (I) California Title 295

It was my first trip round the world flying in a westerly direction, therefore losing one day. I started on Pan American PA 1 from London Heathrow on 27 December 1979 to Houston, Texas, and returned from New Delhi on 26 March 1980 on Swiss Air SR 804. I visited many Members of the Editorial Board and other distinguished scientists, invited most of them to contribute, and as I received only 30% of their promised articles, all was well. I greatly enjoyed these personal contacts, and as the Board Members had now received copies of the Journal for three years, they commented critically on my work.

In Texas I was able to visit friends in Huntsville, where I had a godson, and in Galveston where I had a very dear friend, Lise Darst, the Director of the Museum. After this private week, I flew to San Francisco for the Meeting of the American Association for the Advancement of Science. This was a hectic time, listening to lectures from 8 o'clock in the morning until the last press conference of the day at 8 in the evening. These press conferences, on the hour, every hour, were the most useful part of the AAAS, as they allowed me to attend only those lectures which were really promising.

From San Francisco to Los Angeles, allowing a free morning to visit the Getty Museum in Malibu. There I stayed in the home of Professor Ralph Sonnenschein, a fellow collector of medals. His discipline is physiology, with a chair at UCLA in his subject, and his splendid collection of over a thousand medals is entirely devoted to the medical sciences. My own medals [see Title 74] covered all sciences. Our close friendship survived for many decades.

In those days, one had to apply for a parking space at the Getty Museum before one could visit it. Arriving in the underground parking lot, full of tourist buses and private cars, one had to take a short up-ride in an elevator, and one left it again in the middle of the Garden of a Roman Villa—the actual Museum—in the background. I always thought of this lift ride as my only Time Travel, covering 2000 years in 45 seconds. I found the contents of the Museum, at the time of my visit in 1980, very disappointing when compared with Museums in London. I have not been back since then, and I understand that it now contains real treasures.

From Los Angeles to La Jolla. There I called on Dr Orgel at the Salk Institute, lunched with Dr Harold Urey, met Dr Kurt Benirschke a famous zoologist, had tea with Mrs Szilard, the widow of Dr Leo Szilard of the Manhattan Project and of the first atomic bomb and had dinner with Dr George Müller who had played a leading role in the Apollo Project. La Jolla was to my mind always the most beautiful Science City of California.

From La Jolla return to Los Angeles and on to Honolulu, where I had been invited to stay with Dr Ed Creutz, a Member of the Board, in his small but very comfortable tropical home. A nuclear physicist originally, he had become a high executive of the National Science Foundation in Washington where I met him and where he joined the Editorial Board. He took early retirement from the N S F and was appointed Director of the Bernice P. Bishop Museum in Honolulu, which has an extensive Polynesian collection of the history of Hawaii and its ancient royalty.

This was all new to me and I was fortunate to have in my host a scholar who gladly shared his treasures with me and was able to explain them. So, for example, the royal cloaks were made from thousands of small feathers. But my main interest was the astronomical observatory on Mauna Kea, 4200 m, situated on the Island of Hawaii, whereas Honolulu, the capital, is located on Oahu Island. As Hawaii is the largest island of the group, the whole US State of Hawaii has taken its name from it.

Using the Aloha Airline, I flew 40 minutes to Hilo on Hawaii Island, where I was met by car and driver for the exciting trip of 4 kilometers up to the observatory on top of the extinct Mauna Kea volcano in the centre of the Hawaii Volcanoes National Park. I knew of the established shortly before in 1979, large British infrared telescopic reflector, 3.8 m, and was impressed by it.

Had I still been the Science Correspondent of *The Daily Telegraph,* I would have been able to file an exciting story to London. The British astronomers who had only arrived a few months before me had been unaware of the bitter cold at that height, and when the road down to Hilo on the coast had been cut off by winter weather were isolated in the observatory. They were forced to burn their furniture to stay alive in the sub-zero temperatures at that height.

About 35 kilometers south of Mauna Kea lies Mauna Loa, 4100 m, which is a still active volcano erupting on an average every 3.5 years. On my return drive down to Hilo the driver kindly drove me to it, so that I could see the burning lava flow issuing from one of its fissures. It was an awe inspiring sight, red hot lava coming out of the ground, turning black and cold on its surface, a short distance further down, with the red hot rocks shining through. I had seen many colour photographs and films of flowing lava before, but it was totally different standing near one of nature's great spectacles, the heat-radiating mass of stones, on its slow but unstoppable stream downhill.

What an unforgettable mighty wonder of nature, frightening and of dangerous power.

See Watercolour Title 296, inside Back Cover

Round the World in 90 Days (III) New Zealand Title 297

I left Honolulu on a midnight flight by New Zealand Airlines, on 30 January 1980 and arrived in Auckland, New Zealand, at 09.30, 1 February, having lost 31 January completely by crossing the International Date Line over the Pacific Ocean. I visited Sir Charles Fleming FRS, one of the distinguished Members of our Editorial Board, at Lower Hutt, on the outskirts of Auckland, and was invited to his home for several meals. A great interdisciplinary naturalist, conchologist, ornithologist and botanist, Fleming was always full of suggestions of interesting contributions which I should invite for our Journal. I had seen him regularly during his visits to London.

On one of these occasions, I was extremely lucky to save the lives of Fleming, his wife and of course my own, when I drove them to London Airport in my car. On the motorway, M4, on a hot summer day, I was suddenly confronted by a big lorry coming towards me on my side of the road. It had broken through the dividing central steel barrier and was heading straight for me. I was able to swerve to the left and thus avoid an imminent collision. We speculated about the reason for this confrontation, and thought that the lorry driver had fallen asleep. He took a subconscious avoiding action when he suddenly saw in front of him the traffic jam outside London. Our friendship became even closer after this hair-raising incident.

In New Zealand I was able to spend a few days with my older daughter, Frances Michaelis in Rotorua where she was doing biological research, married to her delightful husband Geoffrey Wells, a New Zealander. They had both studied at the Australian National University in Canberra, where he was taking an advanced forestry diploma course, sponsored by the New Zealand Forestry Commission. After their marriage he had to return to New Zealand to work for three years for the Commission, before he could take a job in the forestry industry in Rotorua. He showed me the forrest and took me to see the giant trees in the hinterland, their felling and transportation, as well as the highly industrialised saw mills of his company. It was not a subject for my Journal, however impressive and interesting, but through his contacts, I wrote a review in praise of New Zealand.

I left New Zealand in the middle of February as I had another family engagement on the 18 February 1980 in Sydney. My younger daughter, Angela Michaelis started her Bachelor of Arts Degree (Honours) on that date at Macquarie University to obtain her B.A. For her degree she wrote a 161-page Thesis on "When is a Story not a Story? A Study of the TV News Item". After graduation in 1984, she found stimulating and satisfying employment with the Australian Broadcasting Commission in Sydney, where she had her own highly successful programme on Australian words and accents. [See also Title 334 on 100 Years Family Tradition]

I only stayed in Sydney for a few days, saw my family, went to a performance at the Sydney Opera House and then flew to Canberra, where I stayed with Arthur Birch in his magnificent home in Yarralumla, the Diplomatic Suburb. [See Title 7] In his usual generous manner, he gave a splendid evening party for me which I enjoyed greatly and where I met Canberra's academic élite. I originally knew him through Frank Sondheimer when Arthur held the Chair of Organic Chemistry at Manchester University. I was pleased when he joined the Editorial Board of ISR, and during our many meetings he told me much about his chemical work, his life and his travels. He was very proud of the fact that he, as an Australian, had started the Chemistry School at Australia's National University and that he was awarded the Foundation Chair in Organic Chemistry.

Another Member of the Board whom I visited in Canberra was Tony Barnett, Professor of Zoology, a truly interdisciplinary biologist, far more than an academic zoologist. His work on animal behaviour with rats was a classical contribution to the subject. The titles of his later books, *Modern Ethology* and *Biology and Freedom* showed his interdisciplinary philosophy and were eloquent proof of his scholarship and his scientific wisdom. Our talks and his suggestions for future articles in the Journal, as well as the excellent meals at his home, were always a great pleasure for me during my visits to Canberra.

I called on Sir Harold White, the Chief Librarian of the Australian National Library, whom I knew well from my scientific film days in the 1950s. He had always considered motion picture films as an integral part of a National Library and had collected an archive of Australia's classical films, including the pioneering films of the early Antarctic explorers, notably *90° South* by Herbert Ponting, one of the greatest documentary films ever made. [See Title 51] It recorded the 1911 expedition by Scott, but as Ponting did not accompany Scott to the South Pole and stayed behind at the base camp, a hut still preserved today near McMourdo, and therefore, he survived. He had filmed much of the preparations and took part in the preliminary trials and today one cannot even imagine his difficulties. He hand-cranked every foot of film he exposed, and then developed it there and then in the Antarctic, having first melted the ice to make up his chemical solutions.

For his superb still pictures, he was even more fastidious. They were all exposed on glass plates and if any failed to satisfy Ponting, he smashed them at once. When I visited Scott's hut in which Ponting had his working corner, I had hoped to find a few of his old broken glass plates, but other admirers of Ponting must have been there before me. Sir Harold White agreed with me in my admiration of Ponting, and told me that his film alone justified all his efforts to include historical moving pictures in the National Library. Thanks to him, my manuscript drafts of *Research Film*, [Title 57] are in the Library for permanent preservation.

As there are no direct flights from Australia to India, one has to change, which I have always done in Singapore. I knew it from my honeymoon [see Title 45], staying at the famous Raffles Hotel in their excellent two-room suites. When subsequently the Hotel became too expensive, I always lived at the Tanglin Club, to which I had reciprocity privileges from my membership of the Cosmos Club in Washington. [See Title 308]

In 1980 it was a 7 hour 45 minute flight from Melbourne to Singapore by Qantas and on to New Delhi from Singapore a further flight of 5 hours 30 minutes by KLM, the Dutch Airlines. For some extraordinary reason, only explicable by the thoughtless timetable arrangements of all the Airlines, one always arrives at New Delhi in the middle of the night, whether one comes from the east or the west. Fortunately, on arrival one can change foreign currency into rupees at the airport, although I learnt to break the law on leaving, and retained some Indian currency, for my next visit which was strictly forbidden.

In New Delhi I always stayed at the home of Professor Romila Thapar, a good friend and a Member of the Journal's Editorial Board. She owned a very comfortable large house where her splendid Major Domo, Bhadur Singh, spoilt me greatly. Romila had for many many years been the Professor, now Emeritus, of Ancient Indian History at the Jawaharlal Nehru University and her hospitality was of truly oriental magnificence. She knew all the academic élite of India and through her brother, Romesh Thapar, the Founder and Editor of *Seminar* I met all the non-academic intelligentsia that was worth knowing.

One of these was Dr Karan Singh, the former Maharaja of Jammu and Kashmir and later the Minister for Health and Family Planning in the Government of Mrs Indira Gandhi from 1967-1977. I got to know him well, and he published two comments in my Journal, one on *Development is the best Contraceptive* (Vol. 13, No. 4, 1988). Lunch in his grand home was always a great occasion with splendid cutlery, plates and large table decorations, all in magnificent antique silver. In a corner of the dining room stood a huge silver water container in the shape of an upright cylinder, one of the objects from his former palace. It stood there, so that his guests were able to wash their hands after eating with their fingers, as is the Indian custom.

Dr M.S. Swaminathan FRS, a geneticist and formerly the Director General of the International Rice Research Station in the Philippines, is generally considered the architect of the 'Green Revolution' in his native India. I was able to persuade him to join the Editorial Board when I saw him in New Delhi. I had visited his Rice Research Station in the Philippines and was glad to publish an excellent contribution later.

I chose the subject of the 'Sea', for a special issue of the Journal, published in March 1981, and gave my Editorial the title *The Sea: — Servant and Master* to point out its important relationship to mankind. As a servant, the sea has supplied us with food and now oil, and as a master it has demanded strictest attention to safety. I pointed out that if man treated his servant, disasters like the sinking of the *Titanic,* the flooding of Venice, and oil pollution would inevitably follow.

Prince Rainier of Monaco pleaded in the first Comment of this issue for international prevention of accidents, like oil spills and oil blowouts. These must have priority, especially in like the Mediterranean, which is closely surrounded by land. His comment was based on his opening speech to the Monte Carlo Conference in May 1980, devoted to 'Petroleum and the Marine Environment'.

The physiology of deep-sea animals was the subject of the next article by Professor E.J. Denton FRS, the Director of the Plymouth Laboratory of the Marine Biological Association of the UK. Their luminescence and vision, and in particular the vertical distribution of these animals was studied by means of recent developments in physical techniques. Just as research on specialised tissues of shallow water animals had proved useful, Denton hoped that similar deep-sea research would be of equal importance.

Other contributions were concerned with the origins of the oceans in relation to the Gaia (Mother Earth) hypothesis and *Safety at Sea* by I.C. Clingan, the Engineer-in-Chief of Trinity House. He found the increase of fires at sea to be considerable during the preceding 25 years, and this led him to recommend that the overall competence of those manning ships was the most important aspect to improve safety. The spiritual and aesthetic interactions between man and the sea was discussed by Sargun A. Tont of the Scripps Institute of Oceanography in his contribution *The Sea: Its Science and Poetry*, quoting a number of beautiful poems. He concluded that man's love of the sea was not explicable by a simple materialistic determinism.

The Flood Problems of Venice was the title of John Earle's contribution, describing in detail the civil engineering solution which existed to prevent future flooding, but which had been rejected by the Italian Government. Professor D.N. Walder of Newcastle University reviewed the progress in breathing mixtures supplied to deep-sea divers in his *Diving Physiology* and outlined future difficulties if ever greater depths are to be reached.

Finally Mr D.K. Brown a member of the Royal Corps of Naval Constructors and of the Ministry of Defence, Bath UK, concluded this very interdisciplinary issue with his historical review of *British Battleship Design 1840-1904*.

To predict the future is an ancient human desire and still today, astrology has more followers than astronomy. It is however remarkable that in my Editorial for this issue, I was able to quote at least four accurate predictions of nuclear power and one of disastrous atomic bombs. It was published in June 1981.

H.G. Wells in his book *The World Set Free* of 1914 was the first to predict that in 1953, atomic power would produce unlimited energy, leading to a revolution in industry and finally world war. (The first atomic power station to produce electricity was Calder Hall, inaugurated in Britain in 1956). The first atomic bomb (a term invented by H.G. Wells in this book) was dropped on the Imperial Castle in Berlin. More than 200 similar bombs followed, all leading to "continuous explosions, and producing soreness and blistering of skin and lungs, very difficult to heal".

Apparently the second prophecy in 1923, was by Professor A.W. Stewart in his novel *Nordenholt's Million* written under the pen-name J.J. Connington. The author must have known of Rutherford's paper of 1919 on "Collision of alpha particles" and extrapolating in the novel, the fictitions inventor of atomic power described correctly a chain-reaction how "one set of disintegrating atoms must trigger a second and a third and so forth". The inventor is killed, others continue, and again produce unlimited energy, a Million survivors are saved to reconstruct a land devastated by the destruction of all green plants and hence condemned to starvation.

Olaf Stapledon was the third who in his classic *Last and First Man* of 1930 described how in the year 2000 a young Chinese scientist demonstrated an atomic rifle with which he destroyed the Island of Lundy in the Bristol Channel and produced a perfect mushroom cloud. Stapledon's description of events was an accurate prediction of the phenomena which took place during the first atomic explosion at Alamogordon, New Mexico, on 16 July 1945.

Hans Dominik, a German engineer and science writer, wrote two books in which atomic power was predicted. In *Der Brand der Cheopspyramide* of 1927, he invented a tactical atomic weapon, a *Kugelblitz* which produced an atomic explosion when in contact with iron. During a war between Arabs and Europeans another version of his atomic weapon is used to set the Pyramid on fire. In Dominik's second atomic book *Atomgewicht 500*, published in 1935, he chose uranium enclosed in an autoclave and submitted it to extremely high pressures of helium and high temperatures which produced a new 'sun-element' of atomic weight 500. A minute quantity of this material was sufficient to keep a 20000 h.p. electric power station running for a month. Before final success could be achieved, explosions and other disasters had to be overcome.

Title 302

L' Automobiliste 1898. A lithograph in a private collection by Henri de Toulouse-Lautrec.
 Courtesy Hayward Gallery, London 1991.

Nothing could have been more interdisciplinary than the contribution by D.E. Tubbs which he called *The Car and its Artists*. Mr Tubbs, a journalist and veteran author of the history of motor transportation, had written and published numerous books and many articles about cars. When I met him, he proudly showed me his latest book *Art and the Automobile* which was published in 1978 by Lutterworth. "Here is something really interdisciplinary" he said and I shared his opinion. He kindly agreed to condense the substance of the book to an article for ISR and I received his manuscript together with 12 splendid illustrations from his own collection in July 1980 and published it in September 1981.

I was particularly interested in his contribution as I had always thought that technology had not inspired artists, perhaps with a few exceptions of railways, ships and aircraft during their historical beginnings. Tubbs soon proved to me that cars were a special case, perhaps because artists themselves owned and drove cars, but never railways, ships or aircraft. Tubbs had found in years of collecting, that eminent artists like Toulouse-Lautrec, Derain, Bonnard, van Dongen, Leger, Matisse and David Hockney have at least flirted with automobile subjects.

The real flavour of car art can only be transmitted through the superb 225 illustrations, particularly of the 50 colour pictures, of Tubbs' 1978 book, a copy of which lies now by my side as I write. Just as the technology of the car grew from the awkward pre-1900 single-cylinder three-wheeler to the supercharged racing monsters of the 1920s and 1930s, so the European artistic styles changed from post-Impressionism, Futurism, Surrealism, to Social Realism. In the United States after World War II, the motor car, celebrated as one of the chief totems of the American culture, finds its mirror in Pop art and Photo-realism. History of technology and of art flow past the reader as he turns the pages of this book of interdisciplinary splendour.

All I can do here is to give brief chapter headings of the book and of the ISR article based on it. Pictures of early motor car races 1895-1905; Ernest Montaut and his school of early poster artists; Futurism to Dada via Rene Vincent; Styling, coach work and interior appointments of the Jazz Age; Art and Architecture in motor car design by stylists; art for the enthusiast as portrayed by Bryan de Grinau, Geo Ham, Peter Helck and others; and finally the car in contemporary art and sculpture.

As a car enthusiast myself, once the owner of a beautiful 1935 four and a half litre silver Lagonda, I must admit that this interdisciplinary contribution gave me much pleasure to read, edit and publish.

Title 303

Science in Germany was born again after World War II in 1948 when Otto Hahn (standing right) became the first President of the new *Max-Planck-Society*, the successor to then extinct *Kaiser-Wilhelm-Gesellschaft. Courtesy Archives of Max-Planck-Society.*

Once before, 18 years earlier, I had published an article on the same subject in the *New Scientist* of 1963; I had then been invited by the President of the Max-Planck-Society, Professor Reimar Lüst, to travel through Germany and visit its scientific institutions. He was of the opinion that I might give an objective opinion whether Science had recovered from the disastrous effects of the Hitler regime during the period of 1933-1945. In 1981, and after several more visits to Germany [see Titles 168 and 212], I considered it right to look again at Germany's recovery and I wrote and published a further article in December 1981. Each time I concluded that it had been achieved partially, but not completely. If I had to review this subject for the third time, say in 2000, my answer would be more positive and I would consider recovery as complete.

In my 29-page article for ISR, published in December 1981, I began with a section on *Finis Germaniae?* World War II had led in Germany to the total physical destruction of most scientific institutions, their laboratories gone, their scientists distributed over the four zones of occupation by the Allied Forces under often exceedingly difficult travel arrangements between the American, British, French and Russian Zones. The Russian Zone later became East Germany, the Deutsche Demokratische Republik, the DDR, to which I have never been able to travel and which I could therefore not include in my reviews.

The main factor for the rapid recovery, already very evident during my 1963 visit, was the experience of reconstruction of German science after World War I. Other factors were the foresight of defeat after Stalingrad in 1943, evacuation if possible to the West and very hard work by all scientists, teachers and students alike. The period of 1945-1960 has been characterised as the most creative one, with exceptional improvisation, originality and productivity. The guiding principles "You are alive—use your life" was then the all—pervading thought.

The currency reform of 1948 and the Marshall Plan, contributed greatly, as well as the re-founding of the Emergency Association of 1918 which later became the powerful Deutsche Forschungsgemeinschaft, DFG, today supporting much of the academic scientific research at the universities. By 1950, more than DM 50 million were available for science. The rebirth of the Kaiser-Wilhelm-Gesellschaft as the Max-Planck-Gesellschaft, as organised by the British Colonel B. Blount, was also a major factor in the rebirth of science in Germany after World War II.

The most outstanding and quickest recovery occurred in the German Chemical industry, due to its emphasis on large-scale research and on the position of chemists at top board level. Pre-war I G Farben was split into BASF, Bayer and Hoechst and soon each exceeded IG Farben in size and performance.

Title 303

Professor Eugen Seibold, a Member of the ISR Editorial Board, was responsible for bringing German Oceanography up to an international level again after 1945. Later he became the President of the German Research Board. *Courtesy Deutsche Forschungsgemeinschaft, Bonn.*

Title 303

Dr Anthony Michaelis (left) showing a copy of his Journal, ISR, to Dr Heinz Riesenhuber (right), the German Federal Minister for Science and Technology at a press conference in Bonn. © *Kemmer.*

Unquestionably the greatest loss to German science in the period of 1933-1945 and particularly during Hitler's senseless war of aggrandisement was the deadly loss of a generation of young men, idealists and scientists of great promise. Equally serious were the anti-semitic Nazi regulations which drove Jews, many of them Germany's leading university professors, to seek safety and employment abroad. That their gifted children, their children's children, and further generations were no longer Germans, was an equally serious loss.

The second great change is that the German language ceased to be the language of science, now internationally replaced by English. If a comment is needed, a German university professor may take three days to prepare a German contribution to an international congress, but may have to spend three times as long to write it in English, if he wants his audience to understand him.

No one would ever state that Hitler's Third Reich had brought any tangible or long-lasting benefits to Germany. However, the post-war experience that Government control is unnecessary for the freedom of great scientific institutions, although financially dependent on official sources, was valuable.

The lessons to be learnt are twofold. In Germany itself, scientists have understood from bitter experience that they must share political responsibility with all others and cannot remain in a state of 'Golden Innocence', as Walter Scheel, President of the Federal Republic, has criticised the scientists of the pre-Hitlerian area. Their loyalty to the State was completely uncritical and subservient. The exceptions were few, Albert Einstein the most notable.

The second lesson concerns other countries, also forced to build, or rebuild, their science: Insistence on excellence in all research, free and independent scientific institutions and small beginnings in simple laboratories, must have absolute priority. The rest will follow, as was exemplified by Chaim Weizmann who started in 1934, setting up a small chemical research laboratory in the deserts of Palestine. It grew to the famous Weizmann Institute in Rehovot. Weizmann recommended frequent exchange visits to other research laboratories abroad. In all re-constructions, hard work is another essential prerequisite, although Liebig's admonition need not be taken verbally: "Ruin your health through hard work as a student, if you want to become a chemist".

My ISR article was translated into German by Professor Roswitha Schmid and published as a paperback of *Naturwissenschaftliche Rundschau* with the title *Wissenschaft in Deutschland—Niedergang und neuer Aufstieg,* 1983. Dr Schmid added many photographs and a list of eminent scientists.

Looking at my Diary of 1981, I am still amazed what a busy year it was, full of exciting travel and enlivened by so many friends. I did not feel I was 65 years old, when most others had retired. January was as usual occupied by a visit to the American Association for the Advancement of Science, meeting for once in Canada's financial and commercial centre, Toronto. I remember the extremely low temperature of -42 °C vividly and how almost every street had a parallel underground street with shops on both levels. One could therefore pursue one's life easily without ever getting exposed to the icy blasts from Canada's north.

The AAAS Meeting has also become memorable for me, as I had been invited by Joseph and Vary Coates to give a paper on "My Interdisciplinary Philosophy" on 7 January at 2.30 pm in the British Columbia Room of the Royal York Hotel. There was not much pure philosophy in my talk, rather more historical description, why I started an interdisciplinary Journal, and how lucky I was to find a publisher, Gunter Heyden. He was prepared to risk some of his capital, whereas I, as Editor, had to risk my scientific reputation. [See Title 261]

Our collaboration worked extremely well, we became good friends, and although Gunter must have lost quite a lot of money, he never once blamed me for this and left the editorial contents of *ISR* completely in my hands. I described in my talk the modified referee system and the special issues devoted to a single theme.

From Canada south to Washington, which was decidedly warmer and where I was in time to watch the inaugural parade on 20 January of President Reagan. I found it a rather motley assembly of various Americans. I saw Dillon Ripley, the Secretary of the Smithsonian Institution again and was able to thank him for his contribution, published in ISR 3/2 [see Title 278]. As the executive head of America's greatest scientific and art-historical institution, his position was one of immense power and this was immediately obvious when one met him. He was a great ornithologist and had published many volumes on Indian and Eastern birds. He was always very friendly to me, in London and in Washington, and I invited him to join our Editorial Board. He accepted but was not very active.

South again to Florida, Cape Kennedy, where I watched the launch of a satellite, and on to Miami where a good friend, Gregory Wolf had become the Chancellor of the International University. It was his practice to lunch every day with his Deans of Faculty and to invite guests to join them and give a talk. This was quite unexpected, and I was unprepared, but it was easy for me to repeat a shortened version of my AAAS address and I remember a lively discussion afterwards.

In June 1981 I visited Hanover to see Carsten Salander, an old friend whom I first met when he was accredited after World War II. as the Science Counsellor at the new German Embassy in London. We liked each other and later met from time to time, either on his visits to London or in Hanover where he occupied a seat on the Board of PreussenElektra, one of Germany's largest Electricity producing concerns. He introduced me to Professor Eduard Pestle, then the President of the Leibniz Society in Hanover, who in turn supported my international endeavours. [See Title 355]

This meeting could have had, in 1987, great importance for the Advancement of Science Associations. Through a tactical fault on my part, however, it led to very little and neither Pestel, nor the Volkswagen Foundation, which generously financed our international meeting in Hanover, are to blame.[See ISR 12/1 and 12/2] I made my first contacts with the Volkswagen Foundation during this visit to Hanover, meeting Dr Borst and Dr Luise Zarnitz who so greatly helped me in 1987. A few days later, I was in Paris to attend the annual meeting of the International Astrolabe Society of which I was President. It took place at the Paris Observatory. [See Title 71]

In July I had organised a Seminar on 'Interdisciplinarity' at the famous Herzog August Library in Wolfenbüttel. It was again Carsten Salander who had introduced me to the director Professor Paul Raabe, who considered such a seminar of value. [See Title 269A] This Library, considered one of the finest in Europe, was founded by August, Duke of Brunswick, in 1604. G.W. Leibniz, himself a prominent librarian of his age, in theory and in practice, was in charge of the Library from 1690 to 1716.

As one enters the great hall housing the original library, one is surrounded by four white walls, made up from the numerous vellum bindings which fill the hall from the floor to the top of the very high vaulted ceiling. The books are arranged in over 20 well-lit rows according to their size.

One thought struck me when contemplating this treasure of scholarship with its notable collection of medieval manuscripts. The small town of Wolfenbüttel, just south of Brunswick, lies in the very centre of Europe, and many victorious armies must have passed through it during the centuries. Yet it was never plundered of its priceless possession. I could only conclude that the captains and commanders of these passing armies were such illiterate soldiers, that they never understood the value of the booty lying at their feet. Or perhaps the great number of books made removal impossible? Not so for the *Palatina* Library of Heidelberg which was packed in 184 wooden crates and on mule-back removed to Rome in 1623 where it is still part of the Vatican Library today. Cardinals were greater bibliophiles than generals!

Title 306

The Cosmos Club in Massachusetts Avenue

Title 306, 309

The Cosmos Club in Washington DC, of which the Author was elected a member in 1986. The Exterior of the Club as seen from across Massachusetts Avenue and one of the beautifully decorated and furnished public rooms. *Courtesy Cosmos Club.*

I was elected a Member of the Savile Club, London, in 1958 [seeTitle 335] and therefore enjoyed the reciprocal privileges of the Cosmos Club in Washington during my frequent visits from the 1960s onwards. I was always able to stay at the Cosmos while I was working in the Nation's Capital and soon felt as much 'at home' there as in my London Club. When the chance came to be proposed for full membership by my two sponsors, Frederick I. Ordway III and Michael Michaelis, I was delighted, although I did not then realise that the procedure for election was more onerous than in London.

For the Cosmos Club, the nominee has to be proposed under one of the following categories: Meritorious original work; Well known to be cultivated; or Recognised as distinguished. My sponsors decided that my eligibility rested upon the fact that I was "Distinguished in Exchange of Scientific Information" and to support their case to the Admission Committee, I was asked to provide a list of my scientific publications. Not having striven for any academic position, I had never compiled such a list; but as I had kept copies of most of my published articles, I was soon able to send a list to Washington. I was surprised how long it was. [See Appendix 2, Authors Bibliography, Title 428]

In addition, my sponsors wanted to support their case by a list of Club Members who were personally acquainted with me, and there were eleven of these. I imagine they were asked to give their opinion about my eligibility, and as at least some of them must have written affirmatively, I was elected on 1 April 1986 as a non-resident Member. Election to the Savile Club had been much easier. There, my sponsor placed my name in a large book kept for this purpose and other members signed, if they approved.

Founded in 1878 by John Wesley Powell, distinguished explorer, scientist and public servant, the Cosmos Club has been described—rightly in my opinion—as "the home of Washington's intellectual élite". Enter the Club, and the visitor is confronted on the left by a wall of more than 51 framed photographs of Pulitzer Prize winners and on the right by more than 30 pictures of Nobel Prize winners, all members, past or present (Numbers as of 1997). No doubt that figure has increased since then and will continue to grow in years to come.

I was very proud when I was elected and particularly so when I learnt about the qualities of its Founder John Wesley Powell. [see *National Geographic* April 1994] He was the first white man to explore the Grand Canyon, the first Director of the US Geological Survey and the first Director of the Bureau of Ethnology of the Smithsonian Institution in 1879.

The first coffee house in London was established in 1652. Also in Europe these pleasant meeting places for gentlemen to drink their then exclusive beverage, flourished in the 17th century. They became centres of political, social, literary and eventually business influence. In such North American cities as Boston, New York and Philadelphia, coffee houses became popular towards the end of the 17th century. They were precursors of the 'Gentlemen's Clubs' which were first established in England when in 1764 Samuel Johnson founded 'The Club' in London. A century later, many other clubs had opened in London and in North America, such as the Savile Club, established in London in 1868, ten years before the Cosmos Club was founded.

"Like attracts Like" and this principle operated strongly in the exclusiveness and growth of London Clubs. White's Club elected only members of the Aristocracy, the Athenaeum only Bishops, Fellows of the Royal Society and Aristocracy, at least at the beginning—until financial necessity forced the Club to be less selective. In North America, the Union Clubs preferred Military Men as their members, and the Ivy League Universities founded Clubs primarily for their graduates. All Clubs are extremely selective, in order to perpetuate by stringent election procedures their high standards and their own class of men and—only in recent years—also of women. It was a lengthy battle for example for women to become members of the Cosmos Club, but not yet of the Savile Club in more conservative London.

A graduation applies to Clubs, and almost like hotels, one might award them a row of stars from one to five, according to location of premises in the city, the sumptuousness and comfort of their rooms and furnishings, their gastronomic standards, parking facilities and in hotter climes, presence of a swimming pool and other outdoor sporting areas, like tennis courts. Entrance fees and annual membership dues will vary accordingly.

But above all, one must feel that one is among one's intellectual peers. Any gentleman or lady, before allowing his or her name to be put forward for election, should make certain that their own standards are neither higher nor lower than those of the existing members, a judgment that should primarily be exercised by the sponsors of new members.

In the course of time, four- and five-star Clubs have found it to be of advantage to arrange for reciprocal hospitality with other Clubs of equal standing in distant cities, so that members can avoid the hustle and bustle of commercial hotels and, even when away from their 'home' club, enjoy the presence of their peers in select surroundings. These hospitality arrangements often bring financial advantage to those able to enjoy them in the corressponding Clubs throughout the world.

The Cosmos Club has 40 reciprocal Clubs in the US, 10 in England, 8 in Europe, 8 in Australia, 7 in Canada and one each in Brazil, in Chile, in Mexico, in India, in New Zealand, in Singapore, 2 in South Africa and 4 in Japan. It is the largest number I know of any Club's reciprocity arrangements as of May 1995, the date of publication of the latest list I possess.

In Scotland, there is the New Club, founded in 1784, situated on Edinburgh's foremost avenue, Princes Street. Owning its house in this highly desirable commercial district, the Club reconstructed the whole premises some years ago, and let out the ground floor profitably. Access to the modernised Club is by lift to the first floor, where by brilliant architectural reconstruction, the ancient oak panelling is beautifully preserved and the rooms are decorated with the portraits of the Club's most distinguished past members, often in military uniform and kilt. Comfortable guest rooms are available on the floors above.

Once when I spent a night there, my neighbour was Mr Edward Heath, the English Prime Minister from 1970-1974. I noticed a chair outside one of the rooms, on which a man was sitting all night. Later I realised that this must have been the Prime Minister's personal bodyguard. In my rating of Clubs, the New Club certainly deserves five stars.

On the opposite side of the Earth, in Singapore, there is another five-star Club, the Tanglin Club, deriving its name from the beautiful local trees which surround it. It is a truly luxurious establishment, befitting the wealthy commercial society of this thriving city-state. With its Olympic size swimming pool, its tennis courts and outdoor eating facilities for breakfast, its ubiquitous air-conditioning indoors, its large and sumptuous bedrooms and its grandiose restaurant, where delicious specialities from East and West can be consumed —the Tanglin Club offers its members, and those who can enjoy reciprocal hospitality, every luxury one may desire in the tropics.

Still further East, in the Australian capital Canberra, there is another five-star Club, aptly called the Commonwealth Club, situated in Yarralumla, the Diplomatic district. Its character befits its members, high-ranking public servants, Members of Parliament, senior academics, diplomats and military gentlemen. By no means as luxurious as the Tanglin Club, its quiet elegance is more reminiscent of the grander London Clubs and their exclusiveness. Its delight is the view from the bedroom windows across Lake Burley Griffin, named after the town planner of the Capital. When I first visited Canberra in the 1940s, this central area was a dusty area of 'bush' and only later a beautiful artificial lake was created, which became a pleasant place for recreation.

Of all the Clubs I know, and my knowledge is far from complete, I give the Cosmos Club a five-star rating and among those of equal rating, I am certain it surpasses its rivals by at least one star.

First to consider the intellectual eminence and qualifications of its members. As of October 1997 there had been 12 Nobel Prize winners in Physics, 8 in Chemistry, 3 in Medicine or Physiology, 2 in Literature, 3 in Peace and 2 in Economics, a total of 30. A photograph of each of these distinguished men hangs in the Passage of Honour of the Club. The first Cosmos Club Member to become a Nobel Laureate was A.A. Michelson in 1907, famous for his experiments together with Morley to measure the Earth's motion through space. Other well-known Nobel Laureates were the chemists Harold Urey, Glenn Seaborg and Melvin Calvin; I had known all three personally. Sinclair Lewis received the Nobel Prize for Literature in 1930; Lord Boyd-Orr and Henry Kissinger were awarded the Nobel Peace Prize.

Equally distinguished are the 52 Pulitzer Prize Winners for their journalistic and literary achievements, the Prize being awarded by Columbia University. It is named after the Newspaper Magnate Joseph Pulitzer (1847-1911). All their photographs hang opposite those of the Nobel Laureates in the Cosmos Club. Suffice it here to say that the prizes were awarded for a variety of distinguished writings like biographical, historical, editorial, fictional, poetic, journalistic and international reporting. I am certain that no other Club has such an illustrious membership.

It is not surprising that the elite of the North American community of physicists, chemists and engineers, of economists, writers and lawyers have been elected members of the Cosmos Club, as its corporate objectives laid down in 1878 for the Club were "The advancement of its members in science, literature and art and their mutual improvement through social intercourse".

The second criteria for a five-star club are the competence of its elected Officers, the style of its public rooms, its library, its gastronomy, the friendliness of its permanent staff, its comfortable bedrooms, its grand building and its publications. In all these requirements, the Cosmos Club stands at the top and in my judgment deserves the title "The Best". The briefest of walks through its imposing rooms proves, through their atmosphere, that over 100 years the highest possible standards have prevailed.

I was honoured by an invitation to give one of the traditional Monday Night Lectures on my personal subject "The Medal of Science: A Bridge between two Cultures." The date was 11 May 1987, just 13 months after my election.

The beginning of the Seventh Volume of ISR allowed me as Editor to speculate about the origin of the enigma surrounding the Number '7'. Seven has a symbolic, some claim an almost mythical and holy, significance among all peoples throughout recorded history. I enjoyed looking up strange and unusual references in the Library of the British Museum to find exceptual examples. The issue was published in January 1982.

Many obvious ones sprang to mind, from the Seven Days of Creation to the Seven Sisters—the Pleiades, the Seven-Years, the Seven-Weeks and more recently the Seven-Days Wars; the trail of seven is continuous in time. It is also ubiquitous, the Chinese have their Seven Sages of the Bamboo Grove, the Muslims their Seventh Heaven, the Jews their seven-candled Menorah and the American Mercury spacecraft with one astronaut aboard, between 1961 and 1963, all had the figure 7 included in their name, as for example John Glenn's *Friendship 7*. Boeing aircraft types all have two sevens in their names, the most famous being the 747. One must also remember James Bond, 007!

I found in the British Museum Library the classic paper by von Andrian of 1901, a 50-page communication to the Anthropological Society of Vienna, in which he listed all possible and plausible collocations of seven in literature. He also mentioned names of towns, like Sevenoaks, Siebenbürgen and Sept-Isles, but not the Seven Seas, first so named by Rudyard Kipling in 1896.

But what were the origins of this universal veneration of the figure seven?

I was able to point to an astronomical origin, the naked-eye observations of the lunar months (4 × 7 days) and of the seven moving bodies, among the fixed stars, the Sun, Moon and five planets. When in prehistoric times agriculture had reached a certain level and days had to be designated for a regular exchange of produce, an interval between the long year and the short day had to be invented, and thus the week came into existence. This interval could have been any number of days, but the first great empire builder, King Sargon I of Akkad (2335 to 2279 BC), decreed a seven-day week in his Empire. He lived for 56 years, established the first Semitic Dynasty and defeated the Sumerian City States. Thus the Akkadian language spread, it was adopted by the Babylonians, and the seven-day week was similarly inherited from him.

It is well-known that the Babylonians were good astronomers, in one of their calendars the 7th, 14th, 21st, 28th and 49th days are specially listed. Did the Jewish sabbath derive from Sargon's seven-day week? Not all mysteries of the seven have been solved, and Sargon's city Agade has not yet been located and excavated. The influence of seven has on the whole been beneficial to mankind, but for the present, its origin remains a subject for further investigation.

For promotional purposes a special label was designed by the publisher, incorporating the enigmatic "7" surrounded by three circles, signifying Society, Science and the Arts, the whole enclosed in the name of the Journal. See below:

To be photographed

Arthur C. Clarke is, after H.G. Wells, the most famous British science-fiction writer of the 20th century. Like Wells, who read biology at Imperial College London, Clarke studied physics at Kings College London, and both let science influence their stories as well as their social conscience. Clarke received many honours from the science fiction community, and on his 80th birthday in 1998 was knighted and is now Sir Arthur.

In 1945 Clarke published in *Wireless World,* his brilliant scientific idea that three satellites in synchronous orbit of 35 700 km above the Earth's equator could, through their radio and television broadcast relays, cover the whole planet as each satellite would remain stationary over the same point on Earth. When in 1965 Early Bird [See Title 108] became the first commercial communication satellite, a new age of telecommunications began. Clarke never patented his idea, and in the following decades communication satellites, the so-called 'comsats' of American origin, were sold world-wide. They spread along the geo-stationary orbit and brought benefits to the Planet Earth. It is a splendid example of the Scientific Temper.

I had known and respected Arthur for many years, always wanted to publish an article by him in ISR and was therefore glad to receive his manuscript "New Telecommunications for the Developing World", so appropriate as Arthur had lived in Sri Lanka since 1956. In his article, published in June 1982, Clarke foresaw that direct broadcasting satellites in synchronous orbit would bring the greatest benefits to the developing world, as they would spread television-education to rural areas easily and cheaply. He referred to Vikram Sarabhai and Yash Pal, the two Indian scientists who had in 1975-76 proved the possibility of such education with the American NASA satellite ATS 6 [see Title 277] by direct television programs to 2400 villages.

Unfortunately, so Arthur told me recently, this experiment had not been repeated and had not found general approval in the Third World. In his article, Clarke quoted Sarabhai who gave the reason for such neglect: "Anything that is innovative is automatically regarded with suspicion. In many nations the Governments are dominated at the top not by technocrats, but by professional administrators, lawyers and soldiers, who are hardly likely to provide the insight, experience and first-hand knowledge of science and technology which are necessary at the decision-making level". Clarke added "The only constraints are political and economic, not technical".

Among other benefits for the developing world, Clarke foresaw the world-wide mobile person-to-person telephones, perhaps as small as wristwatches in the new Millennium, which would make the whole human race 'one big gossiping family'. A prophecy fulfilled, but sometimes too noisily!

This issue carried the Editor's Announcement that as of May 1982 ISR had been merged with John Wiley, the well-known New York Publishers and its English branch in Chichester, Sussex.

In my Editorial I pointed out that food, the end product of agriculture, has always been and will always be produced at the expense of considerable energy, whether human and animal as in the past, or by fossil fuels as at present. On the availability of fuel will depend the future expansion of agriculture for the starving millions of the present and the ever expanding human populations. This special issue was published in September 1982.

Dr Halfdan Mahler, Director-General of the World Health Organisation, appealed for the end of malnutrition, especially of children, as it opens the door to many diseases. 'Food for all' and 'Health for all' should be the twin goals for all national development plans.

Francesca Bray of the East Asian History of Science Library, Cambridge, UK, presented a brief historical perspective of Asian rice, American Maize, the Tropical Tubers and the Near Eastern Wheat and Barley complexes, extending far back in recorded history. Both technology and economic relations, associated with these four crop plants, were discussed.

Dr N.S. Subba Rao, of the Indian Agricultural Research Institute, New Delhi, described research on bio-fertilisers, destined to replace the expensive chemical fertilisers. Nitrogen fixing plants and biological phosphate sources were discussed and the author concluded that the farmer's active knowledge and co-operation are essential, if bio-fertiliser technology is to succeed on farms world-wide.

Drs C.E. Lewis and W.C. Thomas, Associate Professors at the University of Alaska USA, contributed an article on the expansion of agriculture in Alaska, due to three developments, low cost land, low cost finance and trained agriculturists. Success will follow, if research results and technology will be used by farmers.

Dr James P. O'Hagan, Chief of Global Studies of the Food and Agricultural Organisation, sketched the essential developments in the years 1980 to 2000 that were needed to eliminate food shortages in the developing world. Food output could grow in these regions if purchasing powers were redistributed, improvements in international food policy were agreed, and larger food stocks were accumulated. Inescapable was the modernisation of developing country agriculture, difficult and expensive, and for this purpose at least one dollar in six had to be provided through external assistance.

The Editorial Board of *Interdisciplinary Science Reviews* held a wide-ranging discussion on 'Science and Politics' at its Annual Dinner, meeting at Brasenose College in Oxford on 15 July 1982. The discussion covered many aspects of these two topics, but returned again and again to the 'Give and Take' which should take place between scientists and politicians. The Editor was instructed to give this subject his utmost attention and in the next possible issue in December 1982, ISR 7/4, I published Comments from eminent authors in Italy, Germany, India, USSR, and the USA.

The contributions were: "The Significance of 2 December 1942" (the first modern atomic reactor, but see Title 263), by Professor S. Fubini from CERN, Geneva; "Social and Moral Responsibilities" by Helmut Schmidt, former Chancellor of the Federal Republic of Germany, Bonn; "The Challenge" by Romesh Thapar, Editor of *Seminar*, New Delhi; "Interdisciplinary Co-Operation Essential" by Sergei P. Kapitza, Moscow; "Looking across Frontiers" by Eugen Seibold, President Deutsche Forschungsgemeinschaft, Bonn; "The Chilling Effect of Secrecy" by Dorothy Nelkin of Cornell University, Ithaca N.Y; "Ten Highlights for Program Evaluation" by Elmer B. Staats, Former Comptroller General of the United States, Washington DC.

Schmidt was the only politician who had held high executive office among the above authors, and therefore I shall try to summarise his contribution. He started with the obligation of scientists to present themselves to the public, they must explain the results of their work so that these can be clearly understood and applied by society. He continued with the onerous responsibility of the individual scientist and quoted Otto Hahn and Lise Meitner who achieved the first artificially induced atomic fission on a kitchen table in Berlin. If they were held responsible for the atomic bomb, no scientist could undertake any fundamental research, under the threat of such a risk.

He commented on the endless flow of electronic information which might lead to the end of the 'reading culture' and the resulting consequence to society. Neither politicians nor scientists can transfer responsibility to the other. Schmidt made the point that scientists have a uniquely privileged profession, as they can choose their favourite work as their occupation, and privileges imply responsibility. The scientist has to present science, and the public to whom it is addressed must be ready to evaluate and assimilate it.

As Federal Chancellor he tried to ensure that scientific thinking influenced democratic debate, and both scientists and politicians are answerable for the consequences of their socially committed actions as an obligation to society. His contribution was an excellent example of the Scientific Temper.

The beginning of January saw my visit to the East Coast of the USA, the first step towards another Round-the-World Journey, again in the westerly direction. I attended the AAAS Meeting in Washington DC, visited my good friend Derek Price [see Titles 403 and 404] at Yale in New Haven, Connecticut, and stopped briefly in Princeton, New Jersey to meet with Harry Woolf, then the Secretary of the Institute of Advanced Studies. Both were Members of my Editorial Board.

By the middle of January, I treated myself to a weekend with my old friend Dr Peter Witt, whom I had known since my youth in Berlin. He had studied medicine in Switzerland and Psychology in the USA and settled in Raleigh, North Carolina, where he carried out intensive research at the University into the behaviour of spiders spinning their webs under the influence of hallucinogens, soft drugs, and narcotics, hard drugs. [See "Spider Webs: Design and Engineering" ISR 1/4, page 322, 1976]

He lived with his wife in a delightful country establishment which included his private Zoo, where he had an ostrich, a herd of llamas and a rare species of goats. During my visit, a young llama was born and in my honour he named her *Antonia.* It was the only time in my life that I witnessed an actual birth.

A week later I checked in at the Los Alamos Inn in Los Alamos, situated at a height of 2200 m on a plateau in the Jemez Mountains. By the middle of the 20th century the name of this small city in North Central New Mexico had become a legend for any scientist interested in current affairs. It was there, in the Atomic Research Laboratory of the Manhattan Project, that the first nuclear fission atomic bombs had been developed under its distinguished and later much maligned Director, Robert J. Oppenheimer.

My visit in 1982, in the middle of the Cold War (1947-1991), was a scientific pilgrimage to this historical site, where the thermonuclear bomb, H-bomb, had also been conceived by Edward Teller, designed, developed and constructed. The first USA atomic bomb was exploded in 1945, the first thermonuclear bomb also by the USA in 1952, followed by the USSR less than a year later in 1953, by the United Kingdom in 1957, China in 1967 and France in 1968.

During my officially arranged press visit, I did not expect to learn any secrets, and was not disappointed when I was only shown the outside of many laboratory-huts. However, I learnt that Oppenheimer himself had chosen this isolated site on top of a mountain, as he had been a pupil at the Los Alamos Ranch School for boys founded in 1917 by Ashley Pond. He had given the area the name Los Alamos, the Spanish name for a 'cottonwood tree' of the willow family.

See Watercolour Title 314, inside Back Cover

Westwards to Honolulu where I stayed again with Ed Creutz, a Member of my Editorial Board. He advised me that this time I should fly to Kauai, a nearby Hawaiian Island. It is famous for being the wettest spot on Earth and is geologically the oldest of the string of islands which make up Hawaii. I was told when I got there that its minimum annual rainfall is 10.16 m and its maximum 22.86 m (400 and 900 inches respectively). I found it very verdant, raining heavily and covered by thick dark rain clouds—hardly worth a visit.

Westwards to Australia across the Pacific Ocean and losing a day. First to Sydney and then on to Canberra and there at last I met Major General Alan Stretton of the Australian Army, living in quiet retirement. For over a decade, since 1972, I had been deeply interested in disasters [see Title 81], and by great good luck I had found a copy of Stretton's book *The Furious Days—The Relief of Darwin* (Collins-Sydney 1976). It is a vivid, personal and dramatic description of how Cyclone Tracy almost completely destroyed the town of Darwin on Christmas Day 1974.

Immediately after news reached Canberra of Darwin's destruction, Stretton was ordered to fly north to make a Disaster Assessment and at once took complete 'Churchillian' control of the whole situation. He had to deal with 45000 people, isolated in the far north of Australia, and he decided that only a mass-evacuation by air would save them. Civil aircraft were commandeered and after their flight south, the reception for these tens of thousands of refugees had to be organised all over Australia. In this aspect of relief, his able colleague, Colonel Reno Vardanega, also of the Australian Army, was as good in cutting red-tape as Stretton himself. [See also The *Canberra Times* of 20 January 1985]

The people of Darwin were indeed fortunate to have in Stretton, not only a very able and forceful organiser, but also an extremely sensitive and clever psychologist. Every night, he personally broadcast to the People of Darwin a truthful situation report, and thus strengthened their fortitude and patience until their evacuation could proceed. He set up various action-groups responsible for immediate relief in the town itself, bringing back motivation to shocked and listless people, who had lost their all on a Christmas day.

The publication of *The Furious Days* brought virulent attacks to Stretton from Australia's establishment to which he was unable to reply until he retired. Then *Soldier in a Storm* appeared (Collins-Sydney 1978) in which he was able to repudiate the calumny he had suffered. When I saw him in 1982, he kindly inscribed a copy to me and we discussed the International Rescue Organisation proposed by me in 1972 in relation to the Darwin disaster. [See Title 81]

I met two important scientists in Canberra during that visit whom I had not known before: Professor Ted Ringwood, the inventor of 'Synrock' and Dr Susan Bambrick, Senior Lecturer in Economics, both of the Australian National University, ANU. Ringwood had the simple, but brilliant idea that highly radioactive waste products should be enclosed in his invention, synthetic rock. The waste would then be sufficiently inert to be deposited safely for a very long time, not unlike the uranium isotopes which had been preserved over a period of 1800 million years in the natural Oklo reactor in Gabon. [See Title 263]. I subsequently never heard of any large scale use of synrock, nor did I hear any arguments or read of any reasons why synrock was unsuitable for the purpose for which it was invented.

Dr Bambrick was, at the time I met her, an expert in the economics of Australian mineral products and their exports, and I invited her to contribute her views about her field of research. She wrote the article during the following year when she was a Fulbright Scholar in residence at Pennsylvania State College; and it was published in September 1984, ISR 9/3. I considered it an excellent interdisciplinary contribution, dealing with economics, politics, export controls and environmental protection.

Canberra has always been a great attraction for me, being Australia's Federal Capital and 'Science City'. Apart from housing the Premier Research University of Australia, ANU, it also has the hemispherical home of the Australian National Academy, whose Fellows proudly place FAA behind their name, equivalent to FRS in the scientific hierarchy. The central administration of CSIRO, the Commonwealth Scientific and Industrial Research Organisation, is also located in Canberra, from where its many research laboratories throughout the whole country are guided and supported.

During my not infrequent visits since 1945 to Canberra, Australia's Federal Captal, I made many good friends among the Australian élite of science, particularly Arthur Birch, one-time President of the Academy, Tony Barnett, Guy Gresford, Paul Wild, Jim Rendell and Phil Law, all Fellows of the Academy. I had also known and talked with Sir Gustav Nossal, Sir Ernest Titterton and Sir Otto Frankel as well as the following Foundation Members of the Academy, Ian Clunies-Ross, Hedley Marston, Sir Douglas Mawson and Sir Mark Oliphant. Alas, only a few if any of them are still alive.

I remember Oliphant showing me his giant homopolar generator which I never understood. On my first visit to Australia, Hedley Marston entertained my wife and me to lunch and in his kitchen demonstrated how an Australian prepares a pineapple with four strokes of a great knife. For us, fresh from rationed England, it was a shocking waste, but did we enjoy it !

Electronic Information was in 1983, and still is today, subject to exponential growth, although perhaps the steepness of its growth curve may now begin to flatten out. Nothing can grow exponentially for ever. This particular issue of ISR in March 1983 will therefore be mainly of historical interest.

Here I shall begin with a description of the contribution *Integration of Computers and Communications, C + C* by Dr Koji Kobayashi, Chairman of the Board of Nippon Electric Co., Tokyo. Emphasising the impact of space technology and hence satellite telecommunications, the author developed the concept how computer terminals and the communication networks are growing and joined together in C + C. He was of course writing before Internet became dominant.

The development of *Single Chip Computers* and microprocessors was the second contribution by Dr Eric C. Hannah and J. Soreff of the Hewlett-Packard Laboratories in Palo Alto. The growth of applications began with the pocket calculator and smart instruments, and was then seen to climax with expert systems in 1983. The term 'PC' was not yet in common usage.

The emerging structure of the computer-aided managerial world in industry leading to computer-integrated systems was described by Dr Warren Mathews, Staff Vice-President, Product Effectiveness, of the Hughes Aircraft Company in El Segundo, California. As examples, he wrote about single computer control of Radar as well as of Missile Manufacture and Management Control.

Further instances were *Electronic Information for Airline Operations* (Qantas), for *Elected Government* (US Congress), for *Administrative Government* (in The Netherlands), for *Scholarship and Research* (University of New South Wales, Australia), and for *The Social Science* (Santa Monica)—followed.

Philosophically the most relevant contribution came from Professor Derek de S. Price, [Title 403] History of Science, Yale, which he entitled *End of the naked Brain*. He argued that just as Galileo's telescope signalled the end of 'the naked eye' astronomy, so the computer was the end of the unaided human brain. With a computer our mind would be extended, and we would be able to think in three-dimensional pictures and no longer be restrained to linear sequential logic. The next new generation of computers, the fifth, will have capacities for artificial intelligence exceeding our own, he argued in 1983, and we are now well on the way towards this.

My own Editorial gave a brief history of computing and of the inevitable increase in 'leisure' it brought, which I preferred to the term 'unemployment'.

ISR 8/2 *War in Space* and *Challenge of Style* Title 318

The first page of this issue contained the announcement that John Wiley & Sons had given up the publication of the Journal and that the new publisher would be J.W. Arrowsmith of Bristol, the printers of ISR since 1976. John Wiley had started with issue ISR 7/3 and was only its publisher for 3 issues.

My editorial "War and Peace in Space" in June 1983 was a summary of the published facts about Soviet Killersats, US Warsats and Laser Gunships with their political background, leading to the escalation of preparation for war in space. I stated that war in space was nothing new, and that the concept was originated by H.G. Wells's masterpiece *War of the Worlds* in 1898. Laser guns and beam weapons, essential armoury for space soldiers in all science fiction, were a natural development of Röntgen's discovery of X-rays in 1895.

That actual research on beam weapons was going on was revealed to me by Major-General George Keagan, retired Chief of US Air Force Intelligence in March 1977, during a private lunch at the Cosmos Club. He told me that at the Soviet high-energy physics research establishment near Semipalatinsk 'Directed Energy Weapons' were being developed, judging from satellite reconnaissance photographs. Their use would be against hostile satellites and for Anti-Ballistic Missile Defence.

I did not doubt that similar research was also being pursued in US Establishments, as President Reagan announced in March 1983 that an "intensive and comprehensive research and development effort would begin to intercept and destroy strategic missiles in space". Fortunately nothing came of it, because disarmament in space, often enough discussed internationally, was marginally effective. However, research appears to have started again in 2000. [See Title 356 A]

The Challenge of Style by Paul Erni, a former Board Member of Ciba-Geigy, Basle, was an outstanding interdisciplinary contribution. He enlarged the standard definition of 'style', as a characteristic of a work of art, as he considered style to embrace all human activities and in particular in the chemical and pharmaceutical industries. One illustration was 'Technology remembered through Art' in Diderot's *Encyclopédie* of the 18th century and as modern art, Hans Erni's (the author's brother) 'World of Chemistry'.

Industrial illustrations were the 'Spirit of Ecstasy', the figurehead on the radiator of all Rolls-Royce cars, the packaging of products, the clarity of the logotypes and ingenuity of advertisements, all as various aspects of style. Ciba-Geigy, for example, declared the concepts of responsibility, appropriateness and clarity as valid elements of style for the behaviour and conduct of all its staff. Style-consciousness of employees was thus easily developed, once managerial attitude and approach had been generally understood.

Few Nobel Laureates and few Fellows of the Royal Society receive the highest honours to which a scientist can aspire: The Order Pour le mérite and the Order of Merit. Membership of both, regardless of race, sex, creed or nationality, is severely restricted and awarded only to the highest aristocracy of the arts and the intellect. Among them the greatest scientists of the last 150 years have taken their honoured place.

In 1983 the Chancellor of the Order Pour le mérite was Professor Heinz Maier-Leibnitz, a member of the ISR Editorial Board, and he suggested to me that I might like to write about the German Order, as he would gladly make historical material available to me. My article entitled The Chosen Few was published in September 1983.

Frederick the Great of Prussia (1712-1786), wanted to reward exceptional valour in face of the enemy, among his officers and therefore in 1740e founded the Military Order pour le mérite. As Frederick's knowledge of the German language was only rudimentary, and as all his important writings were in French, then the language of the aristocracy and of the intelligentsia, his new order's name was also in French.

He was a monarch of enlightenment and of benevolent autocracy, who not only bestowed the order on his officers, but also on Voltaire and in 1747 on Maupertius, the first scientist to be so honoured. The last recipients of the Military Order pour le mérite were 687 German officers of World War I, as in 1919 the Weimar Republic terminated all military honours. Only one of these is remembered today, although for a different reason, Hermann Göring.

In 1842, another King of Prussia, Frederick William IV (1795-1861) equally enlightened, artistically highly gifted, but politically ultra-conservative, added a civil class, the 'Order pour le mérite for the sciences and the arts' to the existing Order. Among the Founder Members were Arago, Bessel, Berzelius, Faraday, and Gauss. Alexander von Humboldt became the first Chancellor of the civil order. Its Statutes from 1842 on, unchanged today, limit the membership to 30 Germans and 30 non-Germans and any vacancy is filled by election from its peers.

The Order survived the Weimar Republic by becoming a 'Free Association' and in 1929 elected its first woman, Käte Kollwitz, considered 'the foremost graphic artist of social protest in the 20th century'. No new members were elected during the Nazi Period, and in 1950 Theodor Heuss, then the first President of the New Federal Republic of Germany, re-established the Order together with the other two surviving members. With very minor changes, the Order has flourished ever since.

While writing the history of the German Order pour le mérite, it soon became obvious to me that the members of the English Order of Merit were equally to be considered as 'The Chosen Few'. This was particularly so, as already in 1844, Queen Victoria and Prince Albert suggested to the then Prime Minister, Sir Robert Peel, that an "Order to be given for Merit", and that it might be established. No doubt, Prince Albert must have been aware of the new Civil Class of the Pour le mérite founded two years earlier. I am grateful to Sir Edward Ford, the Secretary and Registrar of the Order of Merit, for this, and further private communications.

The suggestion was considered again in 1846, but rejected by Lord John Russell, then Prime Minister, as 'not expedient'. In 1873, Lord Stanhope moved an address in the House of Lords, praying Her Majesty to institute an 'Order of Merit', but it was rejected by the Earl of Granville, then the Foreign Secretary. In 1887 when Queen Victoria was celebrating her Golden Jubilee as Queen, she raised the subject again and Lord Salisbury, then Prime Minister, even drew up the statutes of an Order of Merit, but in view of the then difficult position of the Government, it had to be postponed 'until a new Sovereign was on the throne'.

Finally, Edward VII (1841-1910) founded the Order of Merit in 1902, soon after his accession. Among the first members were three distinguished soldiers, two Admirals and three eminent scientists: the Lords Rayleigh, Kelvin and Lister. The Order is limited to 24 English, and a number of honorary foreign members of which there were none when I wrote the article in 1983 and published it in September. On its foundation the order had two classes, military and civil, but with the death of Earl Mountbatten in 1979, the last Member of the Military Class of the Order of Merit, this class disappeared

Replacement of a vacancy in the Order is by the personal and unfettered gift of the English Sovereign. Since the end of the Military Class, eligibility to the Order is limited to "such persons, being subjects of Our Crown, as may have rendered exceptionally meritorious service towards the advancement of Art, Literature, Science and Learning". By 1983 only three women had been given this award, Florence Nightingale, Dorothy Hodgkin and Veronica Wedgwood out of a total of 135 Members of the Order.

In Appendix (I) to my article, I listed chronologically 196 scientists by discipline, who were Members of the Order pour le mérite. In Appendix (II) I listed the 41 scientific Members of the Order of Merit, chronologically by date of bestowal. As the Presidents of the Royal Society are usually awarded the Order of Merit, I sent them reprints of this article on receipt of the Order and they were always received with gratitude.

Poems of Science was a book by Professor Phillips Salman of Cleveland, Ohio, and John Heath-Subbs of London, published by Penguin Books in the Spring of 1984. It was the first book on this subject I had ever seen, and the Publishers kindly allowed me to print an extract from the Introduction, written by the two authors, and to include in the article a selection of poems before the date of publication. The ISR issue was published in December 1983.

The authors defined their subject as an anthology of poems, written in English and dealing with pure science. Technology was not included. They mentioned the objection which might be made that poetry and science can have nothing to do with one another, as they represented two entirely different ways of looking at the world. Yet they were convinced that both were based on imagination, the common impulse of their creators, and hence found sufficient incentive to compile their selection.

The Introduction continues with a brief and scholarly review on how our knowledge of the Universe had influenced the poetry of science through the centuries. Beginning with the Horatian view that the aim of poetry was to instruct by pleasing, this instruction might just as well be about the nature of the Universe and man's place in it, as about ethics and manners. The examples reproduced in the Anthology begin with the Aristotelian tradition in science in English poems of the 13th century.

Until the 17th century there was some reluctance to replace the Copernican theory with the heliocentric one, and even Shakespeare relied on earlier scientific notions by turning them into images representing his characters. Even Milton, considered more modern than Donne, preferred Ptolemaic cosmology as it worked better for theological poetry, having been used so often before that the reader was used to it.

Newton's laws and Linnaeus's classifications had influence on contemporary poetry, as for example Erasmus Darwin's great botanical epics. [See also ISR 20/4] Blake and Wordsworth, as well as other romantic poets, recognised the effect of science on poetry as attractive and powerful but thought that it ignored other human qualities, like imagination and emotion.

In the ISR article only a small selection of poems of science contained in the authors' book could be included. These were by the following poets and scientists: Chaucer, Edmund Spenser, Marlowe, Ben Jonson, Milton, Cowley, Swift, Armstrong, Erasmus Darwin, Wordsworth, Humphry Davy, Emerson, Clerk Maxwell and Tennyson.

Of all the poems the one I liked best, also as one of the most accurate science-fiction forecasts—comes from *Locksley Hall.* I repeated it therefore in ISR and published it December 1983. Tennyson is considered as the first great English poet to be fully aware of the new picture of man's place in the Universe, as revealed by modern science.

ALFRED, LORD TENNYSON (1809-1892)

From *Locksley Hall*

'I DIPT INTO THE FUTURE.'

For I dipt into the future, far as human eye could see,
Saw the Vision of the world, and all the wonder that would be;

Saw the heavens fill with commerce, argosies of magic sails,
Pilots of the purple twilight, dropping down with costly bales;

Heard the heavens fill with shouting, and there rain'd a ghastly dew
From the nations' airy navies grappling in the central blue;

Far along the world-wide whisper of the south-wind rushing warm,
With the standards of the peoples plunging thro' the thunder-storm;

Till the war-drum, throbb'd no longer, and the battle-flags were furl'd
In the Parliament of man, the Federation of the world.

There the common sense of most shall hold a fretful realm in awe,
And the kindly earth shall slumber, lapt in universal law.

So I triumph'd ere my passion sweeping thro' me left me dry,
Left me with the palsied heart, and left me with the jaundiced eye;

Eye, to which all order festers, all things here are out of joint:
Science moves, but slowly slowly, creeping on from point to point:

Slowly comes a hungry people, as a lion, creeping nigher;
Glares at one that nods and winks behind a slowly-dying fire.

Yet I doubt not thro' the ages one increasing purpose runs,
And the thoughts of men are widen'd with the process of the suns.

What is that to him that reaps not harvest of his youthful joys,
Tho' the deep heart of existence beat for ever like a boy's?

Knowledge comes, but wisdom lingers, and I linger on the shore,
And the individual withers, and the world is more and more.

Knowledge comes, but wisdom lingers, and he bears a laden breast,
Full of sad experience, moving toward the stillness of his Rest.

(Published in 1832)

On 24 June 1997, more than 100 members of the ABSW held a Celebration Dinner in the revolving restaurant on top of the Post Office Tower, London—it was the 50th Anniversary of the founding date of the Association. It started with four science writers: Ritchie Calder (later Lord Ritchie-Calder) of the *News Chronicle*, J.G. Crowther of the *Manchester Guardian,* W.E. Dick, Editor of *Discovery* and Maurice Goldsmith. None of them was alive to celebrate the Golden Jubilee of the Association they had started.

The four founders first met on 3 March 1947 in the House of the Society for Visiting Scientists. It was a lovely house in London, at 5 Old Burlington Street, between Old Bond Street and Piccadilly, and it fulfilled its purpose admirably for meeting scientific visitors from abroad. Started during World War II in the 1940s, the Society was financed through the British Council. I well remember the excellent and cheap meals obtainable there, in spite of severe rationing at the time. As science writers used it for interviewing visitors, it was natural for them to hold their first meeting of the Association there.

The end of World War II was the right time for science journalism to flourish and to grow, as during the previous six years great scientific events had occurred. There was radar, nuclear energy and the bomb, penicillin, synthetic fibres like nylon, jet engines and the dawn of the space rockets, but none had been fully reported and explained to the public. Editors of newspapers recognised the demand from the public for science news, and the ABSW expanded rapidly. I joined it in 1955 on my return from Australia and on becoming Editor of *Discovery.* [See Title 62]

At first the main objective was the establishment of science journalism as a respectable profession for scientists. This was achieved through the many meetings its Committee arranged, particularly luncheons which cost £ 5 at the Dorchester Hotel. In 1949 Julian Huxley became its first honorary member and lent the ABSW great prestige. I was soon elected to the Executive Committee and by 1982 had become its chairman for a few years.

My contribution was to arrange annual luncheons for the ABSW with the Royal Society, a great success. One year we were the hosts, the next we were invited, it worked well and many new contacts came about. I cannot speak too highly of Peter Cooper, who acted as my Secretary of Committee during the time I was Chairman. He made my task a purely honorary one, while he did all the organisational work. In 1995, I was elected a Life Member, a great recognition for me from my peers. [See also *ABSW Jubilee Scrapbook*, and for further information contact ABSW at 23 Savile Row, London W1X 2NB]

Science Journalism was not only a British phenomenon after World War II, it also became widespread in Europe. By the 1950s and 1960s, it was recognised world wide.

The European Union of Science Journalists Associations, E U S J A, was founded on 8 March 1971 by the Presidents of the Science Writers Associations of Austria, Belgium, France, West Germany, Italy, the Netherlands and the United Kingdom. Since then Finland, Denmark, Ireland, Norway, Portugal, Spain, Sweden, Switzerland and Israel (as an associate member), and others have joined EUSJA.

The aims of EUSJA are also those of the ABSW, to promote the exchange of scientific information through the press, radio and television in all European member countries, to establish and promote contacts between individuals and the various Associations. EUSJA achieves its aims by arranging visits lasting about a week, on an average three each year, to scientific and technological places of interest throughout Europe. Mostly these visits are sponsored by a Government or an industrial company showing their own achievements and include pure-science laboratories. Travel inside the inviting country is free as well as all subsistence, which often is of a very high standard. According to availability, a small number of places, two or three, are allocated to each member country in rotation. Within the Member Association the places have to be drawn by lot, as these week's tours abroad are always most desirable. A Central Bureau in Brussels organises all EUSJA's affairs.

I S W A, the International Science Writers Association, is composed of individual members and is, as the title indicates, truly international. Members' names and addresses are published from time to time in a long roster which clearly demonstrates that science writers are now active in Brazil, India, Australia, Ecuador, Nigeria, Ghana, USA, Argentina, Nepal, Kenya, the People's Republic of China, Sri Lanka, Russia, Colombia, Senegal, Saudi Arabia, Thailand, Canada, New Zealand, Costa Rica, Taiwan, Phillipines, Seoul (South Korea), Indonesia, Czech Republic, Japan, Poland, Venezuela, Bangladesh, United Arab Emirates, Ethiopia, and Peru. Of the 229 names in the 1994 list, 79 members live in the USA, 10 in India, 10 in Canada, and a large number in Europe.

The main activity of ISWA in the last few years has been to organise Conferences and Seminars on science writing in less developed countries. It always holds its Annual General Meetings during AAAS meetings in various cities of the USA at which prospective members are invited to participate.

As J.W. Arrowsmith were the publishers of ISR in 1983, and as their offices and printing works were in Bristol, I visited them four times each year for what we called 'press day'. All proofs for the next issue had been returned by the authors, I had collected and collated them and took them with me. It was an easy two-hour train ride from Paddington Station to Bristol Templemead where Mr Perry was waiting for me in his car. He was the representative in charge of ISR production, a delightful person with whom I got on extremely well. Having worked all his life at Arrowsmith's, he was fully conversant with printing techniques, and he ensured that the very high standard of the Journal in all technical production matters was strictly adhered to.

Miss Victoria Arrowsmith, the owner and CEO of the Company joined Ernie, (Mr Perry), and me for lunch in a nearby pub, where any special points, not dealt with in the morning, were settled. James Arrowsmith, Victoria's brother and the Chief Accountant of the firm, often made up the party. It was always a very pleasant occasion, as the informal and harmonious atmosphere of a family business dictated our personal relations. Dashing about in her Citroën 2 CV. Victoria was not only charming and attractive, but also very knowledgeable about printing technology and had chosen to install electronic typesetting early, when it became essential for her century-old business. Both flat-bed and rotary presses were available, some manufactured by the world-famous Heidelberg Druckmaschinen Company.

Travel abroad was no less in 1983 than in previous years, as my new publishers appreciated that the international standing of ISR depended on this part of my activities. In February I travelled to Berlin and Hanover to give a paper on 'Interdisciplinarity', and in March I was invited to Israel for a fortnight's visit which took me to Haifa, Tiberias, Jerusalem, Beersheba, Tel Aviv and back to the Weizmann Institute, from where I had started. A number of good contributions to the Journal had resulted from previous visits, as for example the excellent and unusual article on "Humour, the interdisciplinary Denominator in Science" (ISR 7/4) by Professor Alexander Kohn, whose main extracurricular activities were devoted to the *Journal of irreproducible Results* which he had founded in 1956 and continued to edit.

The whole of May I spent in the USA, including attendance at the AAAS Meeting in Detroit, a most depressing city, as the American car industry was then noticeably in technological decline. At the end of June I was once again in Lindau at Lake Constance to participate at the Annual Meeting of Nobel Laureates. In August I was at the British Association Meeting at Sussex University and in October I visited CERN in Geneva. All these journeys were scientifically interesting and profitable. On 17 October 1983 I gave a party, celebrating '50 Years in England'.

I have always considered the history of science as an excellent medium to underline interdisciplinary wisdom and therefore spent some time in search of suitable examples. One to two pages were devoted in the first issue of each year to what I called "Interdisciplinary Anniversaries", and I gave worthwhile instances of what occurred 25, 50, 75, 100, 125, 200, 300, 400 and 500 years ago. Here, as examples, are some citations published in March 1984. My encyclopædic sources were W. Stein's *Der grosse Kultur Fahrplan* 1981 and later A. Helleman and B.H. Bunch's *Fahrplan der Naturwissenschaften* 1990.

25 Years ago, 1959. From the USSR, Lunik 3 circled the Moon and sent the first pictures of its back. C.P. Snow published *The Two Cultures* and the Washington Treaty declared the Antarctic an International Land of Science. The ball point pen became popular and WHO's fight against malaria with DDT was successful for a time.

50 Years ago, 1934. Harold Urey received the Nobel Prize for chemistry and Piotr Kapitza liquefied helium at -273 °C. Enrico Fermi in Rome introduces the neutrino concept and in Berlin Hitler declares himself *Führer.*

75 Years ago, 1909. Blériot crosses the English Channel in 27 minutes and Paul Ehrlich together with Hara synthesises Salvarsan against syphilis.

100 Years ago, 1884. George Eastman introduces photographic film, C.A. Pearson patents a high-speed steam turbine, and an International Conference declares Greenwich to be the Prime Meridian for planet Earth.

125 Years ago, 1859. Drake drills and finds oil at 21 m depth in Pennsylvania and Charles Darwin publishes *The Origin of Species.*

200 Years ago, 1784. C.L. de Berthollet discovers the bleaching action of chlorine. In Paris Diderot, chief editor and author of the *Encyclopédie* dies.

300 Years ago, 1684. Robert Hooke proposes an optical telegraph, but it is never constructed. The last witch is burnt in England.

400 Years ago, 1584. Sir Walter Raleigh founds the first settlement in Virginia and brings the potato to Ireland. Tycho Brahe, without a telescope, finishes his catalogue of 1000 stars.

500 Years ago, 1484. Savonarola preaches reforms in Florence and is therefore burnt at the stake in 1498. The term 'billion' (10 to the power of 12) is used for the first time by the French mathematician Nicolas Chuquet.

Title 327

Frank Davidson, a Member of the ISR Editorial Board, began his life as a lawyer, following his New York family's tradition, but stepped aside from the straight and narrow legal path and has devoted himself ever since to 'macro-engineering', a conceptual breakthrough which he pioneered, taught at MIT, published in books and journals, contradicting often current economic theories. In 1957 he founded the Channel Tunnel Study Group which some time later led directly to its construction. *Courtesy F. D.*

In the end paragraphs of my Editorial Contributions to ISR, I pleaded frequently for 'Interdisciplinary Wisdom' as neither scientists, engineers, nor politicians alone were able to solve the great problems facing mankind at the end of the 20th century. In his Editorial Comment on "Macro-Engineering" Professor Frank Davidson of the Massachusetts Institute of Technology, strongly supported my philosophy and wrote one of the most cogently argued presentations for the need of interdisciplinary co-operation between engineers and politicians. He sub-titled his Comment "Advice to Heads of Government: The Institutional and Intellectual Gap" and began with the words "Perhaps a few blunt remarks are in order". I published it in June 1984.

Taking as an example the continental water shortage—which the worlds seems determined to ignore—he argued that it could not be dealt with on a short-term, stop-and-go basis according to the prevailing economic theories. Before any economic transactions can begin, Davidson continued, products and services must be conceptualised, designed, produced, tested, transported and assessed: in short—engineered. Concerning water management for the Sahara, Davidson held up Roman macro-engineering as an example which no modern government had been able to repeat. "Our contemporary age has preferred macro-conferences to macro-engineering".

By the term macro-engineering Davidson understood the study of the design, impact, organisation, management and assessment of large-scale technological projects. I described the Apollo Saga [see Titles 163-167] and called it a typical example of Davidson's concept. There are few institutions anywhere that combine advanced training in engineering-management with a career path. He reminded the reader that when the famous French *Ecole polytechnique* was founded in 1794, its original title was *Ecole Centrale des Travaux Publics.* "The world's institutions are to a large extent anachronistic" Davidson continued, "when technological advances can work today so efficiently for environmental and social improvement."

If politicians' perception of what is now possible is so uninformed and at a time when engineers must broaden their culture, he quoted as an example of what can be achieved, the United Nations Model Neighbourhood in Peru, a demonstration town designed by the architect Peter Land. As engineering projects are becoming continental, intercontinental and even planetary, he paraphrased Voltaire that engineering had become "too important to be left to engineers." In the planning for the world's future, financiers and lawyers must play their vital part, as "Things alter for the worse spontaneously, unless altered for the better designedly" as George von Lengerke Meyer once said.

ISR 9/3 *A Scientist as University President* Title 328

On 13 May 1964 Lord Ashby FRS, a Member of ISR's Editorial Board and one of Britain's most distinguished scientists, gave the A.H. Compton Memorial Lecture at Washington University, St Louis, Missouri. To commemorate Ashby's 80th birthday in August 1984, I republished it in ISR. It is the distillation of a lifetime's experience and it is as relevant today as on the day it was delivered. At the end of his Memorial Lecture, Ashby attributed to Compton humility, tolerance, a faith in science and its ethical principles, and especially a world view unlimited by nationality, language or race. In my opinion, these same attributes characterise the life of Eric Ashby.

Beginning with the process of decision-making, even in small groups, for a family, club or college, this is difficult and one of two things may happen: either the group fails to make a decision and it may disintegrate, or someone in the group assumes its leadership. It depends on his skill whether the group's aims are fulfilled, and such is the task of a University Administrator. He has to have the authority and power, and the art of using authority, to secure the consent of the group. The good administrator is not a boss, but a persuader.

Even science and scholarship need administration today, Ashby insisted, as their work is no longer independent of others, and their consent or even acquiescence must be secured. In the universities of today, where expenditure is counted in millions, professional administrators are essential and must act as channels of communication between higher learning and society—and to keep these channels open and fresh, is a challenge to anyone.

Contrary to other human groups, like industry or the army, where decisions are made at the top and filter down, policy at a university originates in the laboratory, at the bench, in the library and round the lunch table. These foci of decision-making have to be coordinated, if the integrity of the organisation is to be preserved. However, there are no rules for the administrator of higher learning, and he must grope his way in darkness towards his principles.

Ashby who had been Vice Chancellor of two British Universities, Belfast and Cambridge, discussed in some detail a practical example of decision-making at this level of administration, and quoting Laplace he found a 'happy tact' an essential part. In his précis of the art of high administration, Ashby gave many examples, no doubt from his own experience. One of his conclusions was that the University President, or Vice Chancellor, should be regarded by the faculty as a delicate machine, integrating information and producing decisions.

Title 329

Professor Gisbert zu Putlitz (dark tie) showing the Author (left) a piece of equipment during their meeting at the Heavy Ion Research Institute in Darmstadt, discussing the Special Issue of ISR 9/4, published December 1984, dealing with Heavy Ions and trans-Uranium elements. From 1978 to 1983, Putlitz was the Director of the Darmstadt Research Institute and after being the Rector of the University of Heidelberg during its 600 Year Anniversary Celebrations, continues now as its Professor of Physics. *Courtesy Darmstadt Institute.*

About 120 km north west from Berlin lies the small town of Putlitz, in the region of Priegnitz, East Germany. This town gave its name, about 1000 years ago to a family of landowners whose present head is the Professor of Physics at Heidelberg University. In 1983 he was elected its Rector, and from 1978-1983 the chairman of the scientific directorate of the Gesellschaft für Schwerionenforschung, GSI, (Heavy Ion Research) in Darmstadt.

I met Professor Dr Gisbert Gans, Edler Herr zu Putlitz (his formal family name), in 1981 and discussed with him a Special Issue of ISR on Heavy Ion Research which was published three years later in December 1984 as ISR 9/4. I liked and respected Putlitz from the beginning and our co-operation prospered in two further Special Issues of ISR in June 1986 "600 Years University of Heidelberg", ISR 11/2 [see Title 347] and in December 1996 "Man—Environment—Technology: Interdisciplinary Science Support by the Gottlieb Daimler and Karl Benz Foundation" ISR 21/4.

In his "Introduction to Heavy Ion Research" Putlitz gave basic explanations and definitions of the subject, briefly outlined the accelerators needed and stated that the GSI in Darmstadt was one of a number of similar research institutes in France, England, USSR, Canada and USA. In Darmstadt at the time, the accelerator was operating approximately 6000 hours a year, 2/3 of a year, and 450 scientists were employed. In addition about 500 other scientists from Germany and abroad were collaborating for various periods.

Six detailed articles described the "Heavy Ion Accelerators", "Nuclear Reactions induced by Heavy Ions", "Exotic Nuclei", "Atomic Physics", "Biological and Medical Research with Heavy Ions" and "Applied Heavy Ion Research", all contributed by staff members of the GSI.

I considered the article dealing with biological and medical applications the most interdisciplinary contribution, whereas the others were predominantly pure physics. Dr Gerhard Kraft, the author of the medical article, explained that the main advantages of the heavy ion beams were in radiotherapy, radiography, microsurgery and diagnostic applications, when compared with conventional methods. The benefits were the good depth dose distribution and the small angular scattering of the heavy charged particle beams. He listed nine heavy ion facilities for medical applications in the world, but in 1984 the heavy ions produced at the Darmstadt UNILAC accelerator only had a maximum range of half a millimeter in tissue.

In his brief outlook, Putlitz speculated on further energy increases of the heavy ion beams, producing in the extreme, a naked uranium nucleus. A number of transuranium elements have been synthesised at GSI since 1984.

It was in 1984 that I was first invited to the Annual Dinner of the Crabtree Foundation, a black-tie occasion without ladies, at University College, Gower Street, London. Since then I have attended regularly, on every third Tuesday in February until my retirement in 1996. I joined not for any culinary reason, as the menu was always the same, soused herring followed by leg of lamb and cheese, but because of the after-dinner speeches, the 'Orations', always praising Crabtree. To me, they represented the highest level of scholarship in the English literature which I could hope to enjoy.

Joseph Crabtree, born 1754 at Chipping Sodbury died in 1854 at Hayworth, Yorkshire. The first meeting of the Foundation, 25 members present, Professor Hugh Smith as the first President in the chair, took place in February 1954. He stated the aims of the Foundation to be "by any methods at our disposal to restore Crabtree to the high station that he deservedly holds in the History of English Literature". By 1997 when *The Crabtree Orations 1954-1994* were published by the Foundation, the membership had risen to over 400 world wide, with a Chapter in Australia, founded in 1975 and a Sezione Italiana since 1994.

Crabtree was more than a literary giant, as was pointed out in Oration after Oration, each discovering a new aspect in the life of this polymath. Poet and intellectual, naturalist and inventor, the circle of his friends included all luminaries of the period from Goethe to Captain Cook and from Coleridge to Linnaeus. There is no end to the achievements in Crabtree's long life, as the scholarly researches of the Orators discovered; at the age of 17 he revolutionised actuarial practice, at 18 invented soda water and at 19 the beer pump.

In 1789, at the age of 35, he proposed the international system of metrication and decimalisation, and in 1846, aged 92 deliberately frightened Wheatstone away from giving a Friday Evening Discourse at the Royal Institution. As a result Michael Faraday had to give an impromptu Discourse, and ever since lecturers at the Royal Institution are locked in a small anteroom before starting their Friday Discourse. I myself discovered this custom when honoured with giving a Discourse on 10 February 1984 on "The Medals of Science". [See Title 332]

Among the great scientific Orators were R.V Jones, physicist, Sir Ronald Nyholm, chemist, and Sir James Lighthill, mathematician, all Fellows of the Royal Society; but the majority were scholars of literature and of the humanities.

Crabtree never existed. It is the greatest and most successful academic spoof ever conceived.

I considered two possible subjects which I might offer as "Crabtree Orations". One was a visit to the Moon by Crabtree, particularly as I had found on a very rare old Moon map, by Cassini 1680, a picture of the 'Moon Maiden' whom Crabtree might have liked to visit. Between 1671 and 1679 the painters Sebastian Leclerc and Jean Patigny drew under the supervision of Cassini, the first director of the Paris Observatory, many sketches of the Moon, which Cassini used for the composition of his famous map, engraved by Claude Milan.

On this map, the Moon Maiden appears very clearly as a miniature drawing of a beautiful young woman, drawn as a natural extension of a lunar crater. It is generally assumed by selenologists to have been a fanciful embellishment by one of the two painters. This map was part of my collection of old Moon maps. As an Oration it would only have been possible if an enlargement of the map, showing the maiden, could have been projected after dinner. This was however impossible. Getting Crabtree to the Moon would have been easy, as during Crabtree's lifetime, the beginning of the 19th century, sufficient imaginary Moon voyages had been published, and I could have chosen one of these. My second possible subject for a Crabtree Oration was "Collecting", as I myself had been an ardent collector for many years [see Titles 70 to 76]. One must be born to be a collector, and one collects what one loves and considers beautiful and important, in my case the Scientific Temper in art.

Collecting can be an intelligent hobby if one has surplus money to indulge it. Some scientific disciplines, like geology, zoology and botany rely on their collections for their research and progress, others like chemistry and astronomy collect data in huge reference works, like *Beilstein,* to compare new results with existing knowledge. Collecting can become passionate addiction, sacrificing everything—to increase and perfect already existing possessions.

To collect needs special knowledge and only experience will teach what is genuine and what is false. An exact definition of the collectible subject is essential, especially when one attempts novel collections, as I did with 'scientific medals' and 'scientific banknotes'. These are good examples of Scientific Temper as I tried to find beautiful scientific items, combining the arts and the sciences.

Collecting is the only human activity to beat entropy for a short time, as according to the second law of thermodynamics, all order will disappear at the death of the Universe, and only single atoms, or parts of atoms, will remain.

'Crabtree as a collector' was also an impossible Oration for me, as I lacked all knowledge of his contemporary literature or art, the only objects which a scholarly gentleman of his period would have condescended to collect.

Title 332

"Scientific Researches!" a caricature of a lecture at the **Royal Institution** by James Gillray 1802. The lecturer was Dr Thomas Garnett, his assistant Humphrey Davy standing behind him with bellows, the Founder, Count Rumford, is at the door and the fashionable audience included Lord Stanhope.
On 10 February 1984, 182 years later, the Author was greatly honoured to be invited to give a formal lecture on "Scientific Medals" at the same Institution, from the same bench. ***Original coloured etching from the Author's Collection.***

The year began with very sad news. My son Robert, then 33 years old, died in January tragically in Sydney at his mother's home where he lived.

My oldest daughter Frances Barbara, 36 years old, married to Geoffrey Wells, lived happily in Launceston, Tasmania, where I was able to visit them in April 1984. She worked there at a Marine-biological Research Institute and Geoffrey was employed as an executive in the Australian forest-product industry. I spent a delightful week with them in their pretty wooden home.

My younger daughter Angela Diana, 32 years old and unmarried, received the Bachelor of Arts (Honours) degree from the Macquarie University, Sydney, on 3 May 1984. I was able to be present at the Ceremony and of course at the party and festivities which followed. Her thesis for the degree was *When is a story not a story? A study of the TV News Item.* It was 161 pages long with many diagrams and I was much impressed with her choice of subject and contents. At the time Angie was employed by the Australian Broadcasting Commission as 'Pronunciation Research Officer' and 'Assistant to the Standing Committee on English as spoken in Australia'. For a time she had her own weekly programes on these subjects.

My Friday Evening Discourse at the Royal Institution, London on 10 February 1984 was, and will be, the greatest scientific honour of my life. These Discourses, started more than 150 years ago by Michael Faraday, are prescribed to last exactly 60 minutes, not a second less and not a second more. A clock strikes 9 o'clock in the evening, the doors open at the first stroke of the bell, the lecturer strides to the table speaking his opening sentence without any polite preamble to the audience. The clock strikes again at 10 o'clock and the lecturer falls silent with the last stroke. It is a formal black-tie occasion, ladies in evening dress, without any questioning of the lecturer, his address being expected to be perfect, without any doubts to be elucidated subsequently. A dinner with the Director, in my case Sir George Porter, preceded the lecture. I had two slide projectors, showing obverse and reverse of my 60 scientific medals simultaneously, and had rehearsed to devote 60 seconds to each medal. It worked perfectly. I spoke about "The Medals of Science".

My second invitation to lecture that year was at the Australian Counter-Disaster College, Mount Macedon, Victoria, on 26 April at a Conference entitled "Human Behaviour during Disaster". I chose as title for my contribution "Interdisciplinary Disaster Research" and published an abstract in ISR 9/3, in September 1984. I had stopped two days in Darwin on my way round the world and there interviewed the Northern Territory Emergency Authorities to determine what lessons had been learnt since Cyclone 'Tracy' destroyed Darwin in 1974. My conclusion was: Hardly any. [See Title 315]

Ueber die

Erweiterung des Antrum pylori und ihre Beziehung zu der motorischen Insufficienz des Magens.

Inaugural-Dissertation,

welche zur

Erlangung der Doctorwürde

in der

Medicin und Chirurgie

mit Zustimmung der

Medicinischen Facultät

der

Kgl. Friedrich-Wilhelms-Universität zu Berlin

am 18. Februar 1898

nebst den angefügten Thesen

öffentlich vertheidigen wird

der Verfasser

Walter Michaelis

aus Berlin.

Opponenten:

Herr Dr. Wilhelm Croner, Assistent an der med. Universitäts-Poliklinik zu Berlin.
Herr Dr. med. Willi Caro.
Herr Cand. med. Rudolf Meyer.

Berlin 1898.

Gedruckt bei L. Schumacher.

Title 333

The Title Page of the thesis for the **Degree of Doctor of Medicine and Surgery, submitted by the Author's Father,** Walter Michaelis, to the Faculty of Medicine of the University of Berlin on 18 February 1898. Note the names of the three Opponents to the thesis still printed on the title, although by then this medieval requirement was no longer exercised. © *Author.*

100 Year Tradition: Degree Theses of Family (I) Title 333

A Thesis is defined in logic and rhetoric as a proposition laid down or stated to be discussed or proved or to be maintained against attack. Later (1653) defined as 'one written or delivered by a candidate for a university degree'. In my family I now have the theses of my father, my own and those of my two daughters in front of me, all bound in full leather. This page was written in 1998.

1898—Walter Leopold Michaelis

My father's Thesis was submitted to the Medical Faculty of the Royal Friedrich-Wilhelm University in Berlin for the Degree of Doctor of Medicine and Surgery on 18 February 1898. It was entitled: *Erweiterung des Antrum pylori und ihre Beziehung zu der motorischen Insufficienz des Magens.* As was customary in his days, it had to be defended verbally and three 'opponents' are listed on the title page. The copy in my possession was inscribed in handwriting to my father's uncle and aunt and dedicated in print to his mother.

Printed, 16.5 × 25 cm, 32 pages; 27 literature references, 76 patients examined. Published: *Zeitschrift für klinische Medizin,* Vol. 34.

1939—Anthony Rowland Michaelis

My own Thesis was submitted to the Faculty of Science of the University of London for the Degree of Doctor of Philosophy in November 1939. It was entitled *The Dehydrogenation of alicyclic Compounds and terpenic Ketones in the liquid Phase.* It is dedicated 'With gratitude to my father, who alone made it possible'.

Typewritten by myself, 19 × 25 cm, 147 pages, 113 literature references.

Published: *Journal of the Chemical Society,* London, 1940, page 1139.

1969—Frances Barbara Michaelis

My eldest daughter's First Thesis was submitted from the Department of Biochemistry to the Australian National University, Canberra, in November 1969 for the Degree of Bachelor of Science with Honours. It was entitled: *Macromolecular Synthesis in Cultured Mammalian and Insect Cells.*

Typewritten (professionally), 19 × 25 cm, 102 pages, 53 literature references.

Her Second Thesis was submitted from the Department of Zoology to the University of Canterbury, Christchurch, New Zealand, for the Degree of Doctor of Philosophy in 1974. It was entitled: *The Ecology of Waikoropupu Springs.* Organised in three parts, General Introduction, Vegetation and Fauna, it contains a 10-page reprint from *The Journal of the Royal Society of New Zealand* 1973, Vol. 3, pp 295-304.

Typewritten (professionally), 19 × 29 cm, (A4) 158 pages *(Continued)*

1974—Frances Barbara Michaelis (continued)

237 literature references, 13 tables, 36 figures and 6 original photographs, some taken underwater.

Published: *New Zealand Journal of Botany,* 1983, Vol. 21, 33-38.

Also elsewhere in parts.

1983—Angela Diana Michaelis

My younger daughter's Thesis was submitted for the Degree of Bachelor of Arts (Honours) at Macquarie University, Sydney, Australia, 1983. It was entitled *When is a Story not a Story? A Study of the TV News Item.* An interdisciplinary study, it was organised in 6 chapters, an appendix and a bibliography.

The purpose of the Thesis was to determine if the word 'story' was only the professional jargon for an item of news, or if a TV news item could be described as a 'narrative'. As a result of this study the author concluded that story and narrative were a 'recounting of events'.

The Appendix contains full transcripts of all 26 items on the main evening bulletins of two TV Channels on 22 June 1983. The terms and symbols used in the transcripts of visuals are defined and explained as preliminary.

Typewritten (professionally), 19 x 29 cm (A4 cropped), 161 pages, 58 literature references, 14 tables, 4 large diagrams (fold-outs).

This historical comparison over 100 years showed me that the requirements for degree theses have increased greatly in depth analysis of subject, hence in length, and have improved substantially in professional presentations due to the use of a personal computer. The increase in length of doctoral theses appears to be an international phenomenon, as it was also noted at the 'Institut für Wissenschaftsberatung Dr Frank Grätz' in Bergisch-Gladbach, Germany, 1999.

This Tradition of Academic Endeavour must have occurred in many other families all over the world. But in view of the many upheavals during the 20th century, continuity of family life was often disturbed—as it was in my case. I am glad, however, that academic achievements have endured so long in the Michaelis family and they look like continuing further into the next generation. At present one of my granddaughters, Julia Wells, was a student of Engineering at the Australian National University and in June 2001 received her First class Honours degree of Engineering. Surely the other three grandchildren, highly gifted and scholarly, may, I hope, continue the family tradition.

I was elected a Member of the Savile Club in June 1958. I was then the Editor of *Discovery.* It was a simple affair, as I was proposed by Frank Horrabin, the well known map-artist of H.G. Wells, and I had 23 supporters who added their names, supporting my election. A large book was displayed for this purpose in the Morning Room of the Club, and one looked from time to time if anyone had been proposed whom one knew, in which case one signed one's name on the relevant page. Twice a year the Admission Committee looked at the new pages of the book, and then wrote to each individual supporting Member, asking for a written statement why the gentleman [no lady] should, or should not, become a Member.

I have a photo copy of the relevant page in front of me now, which the present Secretary Nicholas Storey kindly gave me. My most famous supporter was C.P. Snow, followed by the prestigious political cartoonist David Low whose drawings were at that time published daily in the *Evening Standard.* Then there was Michael Ayrton, renowned as sculptor, writer and universal artist and Roger Manville, the learned historian of the cinema. Now, 40 years later, many of the signatures on my page have become illegible. Of course I can read the signatures of the medical scientist John Bunyan [see Title 31] and of M.L. Anson, an American scientist retired in London, who had become good friends.

The Club was founded in 1868, and when it moved to 15 Savile Row in 1871, it changed its name from New Club to Savile Club. It never changed its name again, although it moved House three times, settling finally in November 1927 at its present premises, 69 Brook Street, London W1. The capital cost of the 90 year lease, alterations to the fabric of the two luxurious private houses, dating back to 1725 and additional furniture, was £ 29000. It was acquired from Lord Harcourt; who had been Colonial Secretary under Asquith. Lord Harcourt committed suicide in one of the two houses.

After I became a member of the Savile and later for many years, I knew little or nothing about its history and the famous scientific members of the past. Only when Garrett Anderson wrote the Club's history in 1993, published by the Club, and called it *Hang your Halo in the Hall!* did I get really curious. I was also much intrigued by Oscar Wilde's pronouncement: "Ah! The Savile Club, a true republic of letters, not a Sovereign among 'em'", but of course he was not a Member. The judgment of a member, Sir John Cockcroft, the famous nuclear physicist, was as follows: "I take my acquaintances to the Athenaeum, but my friends to the Savile". Having got to know the Club better after a few decades, I fully agree with these judgments.

Oscar Wilde's pronouncement about the Savile Club as "A republic of letters but not a Sovereign among them" was certainly not correct for science. After 125 years of existence from 1868 to 1993, there had been more than 300 Fellows of the Royal Society elected as Members of the Savile, among them eight Presidents, the true 'Sovereigns' of science, if ever such a position can be postulated. Among them was Sir William Thomson, later Baron Kelvin, elected to the Club in 1872, the discoverer of the Second Law of Thermodynamics. He must not be confused with Sir Joseph John (J.J.)Thomson, also a P.R.S. and a Savilian, as well as a Nobel Laureate in physics for his researches on the conductivity of electricity through gases.

The first Savilian who received the Nobel Prize in a scientific discipline for his optical and acoustical researches, was John William Strutt. He was elected President of the Royal Society and his name changed to Lord Rayleigh, 3rd Baron, when his father died, and he inherited his title.

The next Cavendish Professor of Physics at Cambridge University to be a Savilian and Nobel Laureate, as well as President of the Royal Society, was Ernest, Lord Rutherford of Nelson, a New Zealander. He was raised to the Peerage and his title has not been inherited.

Two very distinguished medical scientists, Sir Charles Scott Sherrington and Sir Frederick Gowland-Hopkins were both Nobel Laureates and Presidents of the Royal Society, as well as Members of the Savile Club.

Lord Adrian, electrophysiologist, shared with Sherrington the Nobel Prize in Physiology and Medicine in 1972; he was Master of Trinity College Cambridge and Chancellor of the University. He was elected President of the Royal Society and a Member of the Savile Club. In 1942 he was awarded the Order of Merit, as is customary for the Presidents of the Royal Society, when a vacancy occurs in the Order, limited to 24 Members. [See Title 320]

The eighth and last President of the Royal Society,—at least so far—of these outstanding scientists who were also Members of the Savile Club, was Sir Cyril Hinshelwood. He was elected a Savilian in 1922, a F.R.S. in 1929, and he served as President of the Royal Society from 1955-1960, the customary five year term of office. Apart from being an outstanding chemist, he was a painter of considerable talent, and a great scholar of languages such as German, French, Spanish and Italian in which he was highly proficient. Furthermore he conversed fluently in Russian and Chinese, and was able to use and enjoy his fortune by collecting antique Chinese porcelain.

The membership of the Savile Club can be described as a truly 'interdisciplinary republic' where professions mix. SODALITAS CONVIVIUM, the Club's motto, expresses admirably the enjoyment of members as together they talk, drink and eat, in spite of their different backgrounds, accademi achievements and professions. Anderson chose wisely when he titled his history *Hang your Halo in the Hall!* A good word of advice to a new member, or a visitor, holding forth at length on his hobby, only to be contradicted by his neighbour—who often happens to be the world's expert on the subject. It is a golden rule, even for an old member, to inquire carefully into the expertise of an unknown member, if he wants to enter into a discussion.

It is of course quite impossible to give a full list of all the distinguished members of the Savile, and I must restrict myself to mentioning a few names. Among the literary figures: Rudyard Kipling, Robert Louis Stevenson, Max Beerbohm, Sir Henry Rider Haggard, Thomas Hardy, A.P. Herbert, H.G. Wells and J.B. Priestley will always be remembered.

Equally distinguished were the musicians, like the Savilians: Frederick Delius, Sir William Walton, Sir Adrian Boult, Sir Edward Elgar and Sir Arthur Bliss, who brought enjoyment through their compositions and conducting genius to many hundreds of thousands, not only to the Members of the Club. Sir Henry Moore, the sculptor, Sir David Low, the caricaturist, Sir Ralph Richardson, the actor, Michael Powell, the film director, and Stephen Potter, the inventor of 'lifemanship', all added 'sovereignty' to the interdisciplinary republic of the Savile Club.

Geographical location within London determines to a large extent the kind of membership of a Club. In the Savile there were very few lawyers from the Inns of Court and few merchants from the city, but quite a number of medical men from nearby Harley Street.

If the above list deals with the past, let me add a few more scientists whom I had the pleasure of knowing personally at the Club. Sir Arthur Vick, pro-Chancellor of Warwick University, took the chair at an after-dinner talk I gave at the club about "Medals of Scientists". Erasmus Darwin became a good friend [See also Title 375], a direct descendant of Charles Darwin and one of the eleven members of the Darwin family who had been, or were now, Members. Sir John Cockcroft, Nobel Laureate and the first Director of the Harwell Atomic Energy Research Establishment, interviewed me at the Club in 1955 for a job as scientific cinematographer at Harwell, but I did not qualify.

I have always considered my visits to the Club as pure enjoyment. The occasions varied, it might be a lunch with a scientist whom I wanted to persuade to write an article for ISR, or it might have been a Friday 'Candlelight Dinner' with the 'Lady in my Life', Stefanie Maison. When I first told her that ladies were only admitted to the Savile on Friday nights, she refused to come on the grounds that she did not care to go to a place where she was not also welcome on Mondays and Tuesdays. She changed her mind!

When I finally persuaded her to try it, she liked it, and assisted by the charm of Alfredo, the dining-room manager, it soon became a regular habit for us to dine at the Club on Fridays. Alfredo contributed by arranging a special small *escalope de veau* to be prepared by the Chef, known henceforth as *escalope Stefanie.* I am a much heartier eater and always enjoyed the pepper steak and the sweet-trolley. These Friday dinners were always *à deux.*

If I was alone and wanted a meal, the 'long table' in the dining room was the answer. As everywhere in the Club, the service is excellent, and at the long table one always has the chance of meeting new members from the country, or reciprocal guests from other clubs. To the best of my knowledge, I have never broken the golden rule of lecturing about a subject next to a world expert. I was, however, present when Jack Piccard brought his son Richard, then a medical student, to lunch at the long table. Richard started to hold forth on a topic concerning the eye he had just learnt, when his father stopped him with the words: "Richard, your neighbour is Lord Brain". Lord Brain FRS, so aptly named, was England leading neurophysiologist and President of the Royal College of Physicians. Richard knew him by repute but not by sight and stopped his lecture immediately. Where upon Lord Brain said: "Do continue Richard, I am very glad to hear about the latest research on the subject." A typical Savile lunch repartee.

I only know of two scandals, both from Anderson's history of the Club. A politician, George Brown, proposed and invited to a house dinner, made a speech in praise of himself, contrary to all custom, whilst imbibing heavily. Having delivered himself of his speech "he marched from the dining room, tumbled down the stairs and landed insensible at the bottom" as Anderson tells.

The second scandal concerns H.G. Wells who made the daughter of a fellow member pregnant and used this affair as the plot for his book *Ann Veronica.* The incensed father awaited Wells daily in the Club with a revolver, but this was too much, even for the tolerant Committee. Wells was asked to resign, went to the Athenaeum Club and did not return to the Savile until 28 years later, when he was welcomed back.

Nowadays, when visiting London from my retirement abroad I always stay at the Club.

ISR 10/1 *Science comes but Wisdom lingers* Title 339

I wrote my 10th Anniversary Editorial in March 1985, and I took its title from a poem by Tennyson I liked. [See Title 322] For me it summed up the 40 Journals and Editorials that had gone before, and it also expressed hope for the Future. I took the liberty of changing 'knowledge' to 'science' for the title of the Editorial. Together with the Message of Congratulations from Prince Philip [see Title 340], I thought it commemorated the first decade of the Journal in a suitable manner. (I asked Prince Philip to send me this message, as he had done previously for the 10th Anniversary of *The New Scientist* and as all copies of ISR had been sent to him since 1976).

In my Editorial I thanked the Members of the Editorial Board, the Printers and Publishers, and the Authors of the more than 500 contributions which I had by then published. I pointed out that we had been true to the original criteria for the contents of the Journal, that our policy had been international and that not all contributors had been scientists, some had been politicians, some philosophers, some were artists and some clergymen. Just as varied as the authors and their nationality had been the subjects, and so far no repetition had occurred, as there is an infinity of interdisciplinary topics. Knowledge had come to the readers, but had wisdom lingered?

I tried to answer the question why it was easy to acquire knowledge, but rare to have wisdom. I postulated that it might be found in the very success of contemporary science which demanded ever greater specialisation, attention to ever finer details of nature, and ever faster electronic solutions of research problems in real time. Wisdom will only come with humility, tolerance, experience and age, as the Scientific Temper grows slowly and is combined with a world view, unlimited by nationality, language, race and sex.

To achieve such wisdom had been our guiding policy during the 10 years, and we knew that only on rare occasions had we been able to achieve it. We called our first Editorial, 10 years ago, 'Future Affirmative', but we know now that the road is long and arduous. But our faith that interdisciplinary wisdom will ultimately prevail, is unshaken, today as ever.

In July 1985, I also had a very personal experience of the Scientific Temper—I had an implant in my right eye. For the last 8 years I had been treated for the removal of two cataracts by Mr Alan Mushin, my ophthalmological surgeon. In 1977 he operated on my right eye, 6 days in hospital, followed by the wearing of a contact lens during day time, giving excellent vision, but often grave problems. In 1984 the left eye was also operated and an implant inserted with perfect results. A year later this was followed by a further implant in my right eye, only 2 days in hospital and I have enjoyed perfect vision of both eyes ever since. A routine operation for him, but bliss for me.

BUCKINGHAM PALACE.

In the days of Leonardo da Vinci it was possible for one man, admittedly a genius of a man, to comprehend and even to contribute to virtually all the existing branches of science. Since then, with the growth of knowledge, science has split into innumerable specialities. As some commentators put it, scientists today know more and more about less and less.

The problems that arise in nature do not generally fall neatly into academic disciplines. They have to be viewed by people with broad interests or by teams of people drawn from different disciplines. Since the scientific journals of the world tend to follow the disciplinary specialisations, the existence of a journal explicitly devoted to questions across disciplinary boundaries is immensely useful to scientists and engineers. I am sure they would all like me to take this opportunity to congratulate the editor, Dr. Michaelis, on the success of the Review over the last ten years and to hope that it will continue for many more.

Philip

1984

Title 340

Prince Philip's, Duke of Edinburgh, Message to the Author on the 10th Anniversary of **Interdisciplinary Science Reviews.**

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I met Professor Sarvepalli Gopal in the New Delhi home of Professor Romila Thapar where he was a frequent and very welcome visitor from Madras, his home. As I stayed in her house whenever I came to India, Gopal and I soon became good friends and I learnt to respect his profound scholarship of Modern Indian History, the subject of his Chair at the Jawaharlal Nehru University in New Delhi. Romila Thapar's chair at the same University was devoted to Ancient Indian History, about which she published extensively and had acquired a world reputation, a Fellowship at Lady Margaret Hall, Oxford, and a Distinguished Visiting Professorship at Cornell University and many other honours. Gopal's special field was that of Nehru himself, having written a three volume biography. Following this, he became the Editor of *Selected Works of Jawaharlal Nehru*, of which by 1985 16 volumes had been published by the Jawaharlal Nehru Memorial Fund.

Gopal was the son of the second President of the Republic of India, Sarvepalli Radhakrishnan, a great philosopher, a distinguished Sanskrit scholar and for some years at Oxford University before he was elected President. Gopal was also a Fellow at Oxford, at St Anthony's College, which he often visited. I discussed with Gopal his special interest and soon learnt about Nehru and his scientific education in Cambridge and his many actions as Prime Minister of India, furthering science and technology which, together with socialism, were to transform India into a modern State. His philosophy was the Scientific Temper.

It was obvious to me that I should publish an article by Gopal about "Nehru and Science" which after some delay, I received with the sub-title "Aspirations and Achievement." It was a perfect contribution, scholarly and critical, and it firmly established Nehru among the 'illustrious few' who combined statesman and scientist in one interdisciplinary person. I consider Benjamin Franklin as the first, Chaim Weizmann as the second and Nehru as the third. (Neither Margaret Thatcher [FRS sic] nor De Valera, both scientists to some degree, qualify, as their life's work was devoted to politics and not science-inspired).

Nehru was born in 1889 in Allahabad, the son of a prominent lawyer and as usual during the time of the British Raj, he was sent to England for his education. For him it was the public school of Harrow, followed by Trinity College, Cambridge, and the Inner Temple. From 1912 to 1919 he was engaged in legal practice in the Allahabad High Court and from 1919 on, as a Member of the Congress Party, he was active in politics. From December 1921 he was imprisoned by the British in India for four months, followed by six further terms of imprisonments, the last for four years, ending in 1945.

In his classic contribution, Gopal wrote that Nehru's first interest in science was initiated by his private tutor F.T. Brooks, who improvised a tiny laboratory for him. At Harrow, Nehru's time was taken up by modern history and politics, and only when he went to Trinity College, Cambridge, in 1907, did science become truly dominant in his studies. He took a Natural Science Tripos with chemistry, geology and botany as his subjects.This period was crucial for his life as it developed in Nehru not only a general interest in science, but a scientific approach to life and to the problems of India.

What Nehru affirmed in England was his concept of a civilised person, the application of reason to human affairs, tolerance for dissenting opinions and a search for truth, all revealed to him by science. This Scientific Temper meant a secular policy towards religion and a fight against bigotry, so prevalent in the masses of the Indian Poor. In addition Nehru accepted the Marxist analysis of the past, but not its prescriptions for the future. The long terms of imprisonment were for Nehru a golden opportunity for wide and intensive reading about science and socialism as advocated in the writings of British progressive scientists like Bertrand Russell, Bernal, Needham, Huxley, Waddington, Hogben and Haldane. They had a far-reaching influence on Nehru at the time, a result never expected by the British Prison authorities.

This prison period laid the foundation for several slogans of his, like 'Science for a free India' and the all-embracing '*Scientific Temper* ' which guided all his subsequent actions. When after Independence, Nehru became India's first Prime Minister in August 1947, a position which he retained until his death in May 1964. His first decision on becoming Prime Minister was to assume the Presidency of the Council of Scientific and Industrial Research, a post he kept all his life. In the same year he established a Ministry of Scientific Research and Natural Resources. From 1947 until his death, to encourage India's younger scientists, he personally, later a dynastic tradition, inaugurated each Session of the Indian Science Congress, the equivalent of the British and the American Associations for the Advancement of Science.

In all these activities Nehru's first priority was always the use of science for the economic and spiritual development of India, through research in industry and agriculture, a search for truth through experiment and a vigorous battle against religious bigotry. Nehru felt that the spread of scientific knowledge should reveal the absurdity of its co-existence with superstition and astrology.

In his brief 17 years, Nehru laid the grand foundations for India's future through science, but as Gopal wrote, Nehru's legacy has yet to be fulfilled. Most unfortunately, as any visitor to the great country of India will notice, bigotry and astrology still flourish.

More than 2500 people had to die and more than 200 000 had to be seriously injured in Bhopal, India, to preach once again the single lesson of high technology accidents: ***Accident avoidance is cheaper than paying repairs and compensation.*** It cannot often enough be repeated and should be displayed in all boardrooms from which high technology industry is controlled.

There is only one **Implacable Law** for all high technology Industry:

- Accidents are unavoidable, they are always unexpected and unpredictable.
- Plant maintenance must be at the highest level and no short-cuts tolerated.
- Plant operators in control must be highly trained in emergency procedures.
- Their status and their salaries must be in relation to their responsibilities.
- Back-up duplication and emergency power generators are mandatory.
- Only the most modern computer aided instrumentation can increase safety.
- Highly trained and often rehearsed rescue services must ever be on standby.

At Bhopal in Central India, on 3 December 1984, 35 tons of liquid methyl isocyanate [MIC] escaped as gas from a faulty Union Carbide storage tank in the middle of a large city. It was the most serious industrial accident of the chemical industry ever, and since the poison gas warfare at Ypres during World War I in 1918, nothing like it had ever recurred.

Methyl isocyanate is a highly reactive intermediate chemical with the low boiling point of 35 °C, used in the synthesis of the pesticide Sevin. Normally stored under refrigeration it can be safely handled, but according to Indian scientific reports, Union Carbide had introduced strict economy measures, refrigeration had been curtailed, staff had been reduced and faulty components had not been replaced. The deadly nature of the escaping gas was not at first realised and thus casualty figures mounted rapidly. In fact only after this accident was the biological danger of MIC investigated.

In my Editorial, ISR 10/3 published in September 1985, I stressed the need for high executives in the chemical, atomic and petroleum industries to make themselves acquainted with the great sums of money which had to be paid after previous accidents for compensation and for repairs. They would then realise that plant maintenance and adequate replacement stores, as well as good operator salaries, were cheaper and thus justifiable to the company's accountants.

On 3 December 1999, 15 years after the accident, a large, silent Memorial Service took place at Bhopal. I hope its lessons will never be forgotten!

ISR 10/4 *The Medal of Science* Title 344

Under a previous Title 75 I described my fascination for medals depicting a scientific subject, how I collected them, and how I have lectured and written about them. After my Discourse at the Royal Institution in February 1984 [Title 332], I wrote a definitive article for *Interdisciplinary Science Reviews.* Here I shall repeat the introductory summary and give a few details of the illustrations I used in my article, published in December 1985.

"During the last four centuries medals have been struck which commemorate individual scientists and technological masterpieces. In recent years a third category has been added, the abstract art medal of science. These three classes are reviewed and it is concluded that the medal is the only art form in which science and technology have found a rich and varied representation. It is the permanence of the medal over centuries which distinguishes it from all other scientific records, and thus, if information is to be transmitted over very many years, the artist has the responsibility of interpreting science on the medal in the clearest possible manner. Some medals are criticised and the absence of a catalogue of scientific medals is regretted. As a Bridge between the two Cultures, the study of scientific medals is recommended to the historians of science and art historians."

My article was illustrated with 17 typical examples, all from my own collection, about 1100 medals, which is now in the Library of the Deutsche Museum, Munich. The oldest medal was that of a comet, perhaps Tycho Brahe's Great Comet, struck in 1578, copper, 30 mm, which I once found in an Amsterdam coin shop. Its inscription read: ASTRUM OFFENSI NVMINIS [The Star hurts nobody]. Next to it, I was able to reproduce an exact copy of this medal, struck in 1881. I do not know who issued these two medals, but their intention is clear, namely to counteract the superstitious fear of comets.

I was proud to reproduce a rare medallion, 150 mm diameter, of Mary Somerville by David d'Angers privately cast in bronze, and a Wedgwood medallion in blue jasper of Sir Isaac Newton, first produced before 1780, 107 x 79 mm. Other noteworthy medals were the first Sputnik, 1957, and of the first footprints of Man on the Moon, 1969.

I considered a medal honouring C.F Gauss PRINCEPS MATHEMATICORUM as an example of abstract art, because it showed in the centre a three-dimensional representation of the Gaussian Distribution Curve; it was struck in 1981 by the Paris Mint. The Curve was repeated on the reverse by eight similar curves in miniature surrounding the centre, 70 mm diameter, nickel, edition 150.

This large Collection of many scientific disciplines is unique, but as far as I know, it has not been continued.

Interdisciplinary Thoughts I. Title 345
Foreword by Lord Ashby: *Bridges between the two Cultures*

In 1968, on the occasion of the 10th Anniversary of ISR and of my 70th birthday, I published an anthology of the 38 Editorials I had written so far. [A second volume followed in 1996]. I was able to afford this private printing, as an old friend from student days, Dr Sue Donahue of Staaten Island New York, had generously remembered me in her Will.

I thought it appropriate to have a Foreword to my Anthology and asked Eric Ashby if he was prepared to write it. He agreed immediately and called it "Bridges between the two Cultures". I asked Lord Ashby, as I admired him most of all the 75 members of the Journal's Editorial Board, and when I had to write his Obituary in 1992, I said that he merited the epitaph "great". In my opinion he surpassed all scientists I had ever known in his outstanding human qualities, his humility and his tolerance, his uncompromising faith in science and its ethical principles, his far-sighted world view, unlimited by nationality, language, sex or race.

Of course I was not alone in admiring Eric Ashby. He did not achieve nobility and distinction through his botanical researches and his teaching at the University of Sydney, elected FRS in 1963, but through his services to the Australian and British Governments in war and peace. Knighted in 1956, and through his devoted services as University Administrator in Belfast and as Vice-Chancellor of Cambridge University, [see also Title 328] he received a life peerage in 1973. As Master of Clare College, Cambridge, he hosted our Editorial Board Dinner there on 13 July 1983 at which I welcomed in my annual report our new Publishers, J.W. Arrowsmith. The dinner itself was a real 'feast' in the true academic tradition of Cambridge and Oxford.

The Foreword Eric Ashby wrote for my Anthology is the greatest compliment I have ever received, and I am proud to quote from it: "The Journal [ISR] is his creation, he has shaped its style and controlled its content".... "One of the remarkable features of ISR are the brief and lucid Editorials, all written by Michaelis. They have conferred a pattern of cohesion upon what might otherwise have been a disparate collection." ... "They reflect Michaelis's deep concern with Man's destiny, with the ways in which science could be used to enrich civilization, or to destroy it." ... "Throughout the Editorials there run vivid threads of compassion." ... "I am glad that he has occasionally indulged in his lighter enthusiasms, as in the seventh volume, where he discourses on the symbolism of the number 7 with fascinatingly obscure references." [See Title 310] ... "His 70th birthday is an occasion for his readers to congratulate him and to thank him for some 40 years of hard work interpreting science." ... "It is a pleasure for me to be a spokesman for these congratulations and thanks."

This was the second contribution to ISR on the subject by Dr Alexander King, a good friend from student days, and a Member of our Editorial Board. (The first was published in ISR Vol. 4, No. 1 page 54, 1979, the second in ISR 11/1 in March 1986). Dr Aurelio Peccei, an Italian industrialist, and Dr Alexander King, a British chemist and Science Administrator, met in 1967 and discussed the many difficulties facing today's world, later termed the *Problématique.* They decided to invite 20 senior European personalities from different professions to consider these problems in greater detail. Their first meeting took place in Rome in April 1968, hence the name 'The Club of Rome'.

In fact King, later the President of the Club of Rome, had in mind to follow the example of the 'Lunar Society' of Birmingham at the end of the 18th century. There, on Moon-lit nights, (to return home safely) eminent scientists and industrialists talked about their problems, and their conclusions first triggered the beginnings of, and later catalysed, the Industrial Revolution.

The strength—and weakness—of both was the absence of any formal organisation, of any structure and their independence of any financial constitution. Like an American think-tank, the aim of the Club of Rome was to influence policy through the creation of a better understanding of the complex tangle of contemporary global problems. Their conclusions were to be communicated to Heads of State and to the public, to lead to a better world.

Membership of the Club of Rome is international and consists of eminent private citizens, acting together as catalysts, desiring no political power, nor inventing any new ideology. These aims were excellent and met with widespread approval. After an invitation I joined the London Branch of the Club of Rome at the Athenaeum Club and often participated in their interdisciplinary discussions. However, as no opportunity offered itself of communicating with decision-makers, I decided that simply talking about the problématique was sterile, and I resigned. I was sad, as King's basic concept for the Club of Rome was "the cultivation of interdisciplinary approaches", the same policy as of ISR. King had come to the same conclusion as I, namely that today's problems were too complex to be solved in isolation by politicians, by economists, engineers or scientists.

The greatest success of the Club of Rome was the publication in paper-back in 1972 of its report *Limits to Growth* prepared at MIT by a team of young scientists under the guidance of Professor Dennis L. Meadows. More than 5 million copies in 30 languages were sold. It was a controversial book and widely attacked by conservative economists. However, it achieved its aim, informing experts and the general public about the limits of resources that exist on our planet.

The Special Issue on 'Heavy Ion Research', ISR 9/4, which at the time was under the direction of Professor Gisbert zu Putlitz [see Title 329], was highly successful. When Putlitz became the Rector of the University of Heidelberg, and it was about to celebrate its 600th Anniversary, he asked me again to prepare a Special Issue of my Journal for this event. I was glad to undertake this task, as it was to be sent to old alumni of Heidelberg all over the world, and 15000 copies were printed. It meant several visits to Heidelberg to organise the contents and many interesting discussions with the authors at the oldest University in Germany, founded in 1386. A splendid cover was designed for this Issue by Osswald, the crest of the University, surrounded by a multicoloured pattern, many vertical lines and two rings. It was published in June 1986.

As a motto for its celebrations, the University had chosen 'From Tradition into the Future' and this was also the title of the first comment in the issue by the Rector, Professor zu Putlitz. He emphasised that the contributions by senior Professors were not only commemorating the great traditions of the past, but were also pointing to an even greater future. He stressed the University's wide spectrum of disciplines, the interdisciplinary nature of its research, the stronghold of freedom for its academic staff and the proven stability over 600 years in overcoming the many challenges which had occurred during its history.

It was a large issue of 123 pages (96 pages normally) and contained 24 contributions. I began with my usual Editorial which I called *Gaudeamus igitur* 'Let us then rejoice', the title of the old academic drinking song. I rejoiced that the great old European Universities, like Heidelberg, had made almost all the important contributions to our Western Culture. I rejoiced that they were quickly imitated in Non-European countries when conditions became propitious and that they had guarded the traditions of freedom of research and teaching. Herr Lothar Späth, Prime Minister of Baden-Württemberg, the Land in which Heidelberg is situated, also contributed a Comment on the subject of "University and Society" sketching the political history which led the Duke-Elector Ruprecht I. to found the University and how it had served Society, time and again, by grooming individuals for leadership.

A further Comment was written by Professor Eugen Seibold, a Member of our Editorial Board, on "An international Network for the Universities", in which he pleaded for partnerships between Heidelberg and other Universities. He made the interesting point that the mediaeval language of scholars, Latin, had been replaced today by the English language, and that Heidelberg was the German city in which English can be heard most often.

ISR 11/3 Archaeology and the Disposal of highly radioactive Waste Title 348

Nothing could demonstrate more clearly the nature of independent thought by a scholar, when applied to a great interdisciplinary problem and leading to an acceptable solution, than this article contributed by Dr Maureen E. Kaplan of Lexington, Massachusetts. It was published in September 1986. Her doctoral research involved neutron activation analysis of ancient pottery from the Mediterranean, and her thoughts were directed to the archaeological study of long term survival of human artefacts, such as Stonehenge. I met her at an AAAS Meeting, liked her and invited her contribution.

There is one problem where her researches needed an urgent application, namely the marking of the deep burial sites of highly radioactive wastes. Even at the time of my writing this,(2001 AD) no country has yet decided on the deep burial of these dangerous wastes, and therefore Kaplan's studies and her solution still remain only a theoretical proposal. I thought it was an excellent one, and her Manuscript was received in my office on 5 June 1985.

Dr Kaplan's basic problem was to design a marker on the surface which would indicate to humans in, say 10000 years' time, where there must be an absolute prohibition to explore below ground. She started by pointing to human edifices which had survived millennia and assessed their suitability as markers. The Pyramids in Egypt, 4500 years old, were too massive to be effective repository markers. The Acropolis in Athens had suffered more from human environmental attacks, than from the ravages of nature, and hence possible markers must also be protected against pollution. The Great Wall of China, more than 2000 years old, had required continual maintenance, a labour to be avoided, as it cannot be preplanned. Wall carvings in Ancient Egypt had been destroyed by salt crystallisation and therefore excellent drainage would have to be provided for the suggested markers.

Kaplan concluded that only the monoliths of Stonehenge provide an archaeological example to be followed. Hard stones, like basalt or granite, must be used, as metals rusts or if precious, would be recycled. The markers should be twice the height of the human figure, their surface be highly polished to prevent water attack, and they should carry written messages in English, French, Arabic, Spanish, Russian and Chinese. The markers should also endeavour to convey the prohibition in symbols and in pictures, showing for example one man, out of three, who had disobeyed, had suffered and falling down, died, while the two on his sides, remained standing.

Thirteen years after this publication in ISR, G. Benford published his book *Deep Time—How Humanity communicates over Millennia* (Avon 1999), the results of a highly-endowed Commission of Enquiry for the US Congress. I was delighted that ISR was first again, and that Kaplan had succeeded.

I had become aware of the extent of natural and man-made disasters in the late 1960s when working for the *Daily Telegraph* and therefore proposed an *International Rescue Organisation* in 1967 [see Title 81] in order to overcome the shocking waste and inefficiencies when help for disaster victims was attempted.

In my major analysis "Disasters—Past and Future" of 1972 I defined:

Accidents less than 1000 dead or in imminent danger of death
Disasters 1000-1000000 dead or in imminent danger of death
Catastrophes more than 1000000 dead or in imminent danger of death.

I had always invited, and kept my eyes open, for possible articles on Disasters and by the middle of 1986, I had enough material to prepare a Special Issue of I S R on the subject; it was published in December 1986.

I devoted my Editorial to *The Martyrs of Science*, an article I had written for the *Daily Telegraph* [see Title 155] in 1967 after the Apollo 1 fire, but it was never published. I expanded it for this Special Issue and named those scientists who had given their lives in ballooning, aviation, in the Arctic and Antarctic, as explorers of distant lands and in underwater research. I headed the Editorial with a message to the public, written in March 1912 by Captain Robert Falcon Scott RN when dying on his return from the South Pole

We took risks, we knew we took them;
Things have come out against us,
And therefore we have no reason for complaint.

Michael Michaelis, Washington DC, contributed an excellent Comment on the two accidents "Challenger and Chernobyl: Why?" and traced the causes of both to 'human failure'. This he based on lack of vital information, arrogant attitudes, and flawed decision-making in case of the spacecraft accident. For the Chernobyl atomic disaster (12500 dead), the Investigating Commission threatened operators causing a further accident through human failure, with police and criminal proceedings. In the opinion of the author, this added further unbearable stress to taking proper corrective procedures. He pleaded for a proper scientific investigation of the phenomenon of 'human failure'.

The other outstanding contributions to this Special Issue were:

- Disasters and the United Nations* Sir Robert Jackson of the UN, New York
- Drought* J.H. Hulse and V.J. Escort, Ottawa, Canada
- Disaster Planning* Harold D. Foster, University of Victoria, Canada
- Dangers of Hydromagmatic Volcanism in Italy* A.M. Duncan *et al.,* England
- Technologies: Accident, Crime and Terrorism* R. Westrum, Michigan, USA
- Ice Problems for Ships and Structures* A. Joensuu, Wärtsilä, Finland

Dinners of the Editorial Board — Title 350

The original Editorial Board of I S R at its inception in 1976 [see Title 262] changed through the years, as members died and others joined the distinguished company. It was always my intention to keep in close personal contact with them, but of course distance and time prevented this. The simple solution was to have an annual meeting and report there and then on the progress of the Journal and to receive the comments of the Board. I was lucky that a number of the English members were fellows of Oxford and Cambridge Colleges, and when it was decided to combine the annual meeting with a dinner, sometimes a lunch, I was again fortunate that these pleasant 'feasts' could take place in their Colleges, the costs being defrayed by the publishers.

1976	The Cosmos Club, Washington, D.C.	Host: The Editor
1978	The Savile Club, London	Host: The Editor
1980	Clare College, Cambridge	Lord Ashby
1981	Goldsmith Hall, London	E.T. Hall
1982	Brasenose College, Oxford	Nicholas Kurti
1983	Clare College, Cambridge	Lord Ashby
1984	St Anne's College, Oxford	Miss V. Arrowsmith
1985	University of Bristol	Miss V. Arrowsmith
1986	Churchill College, Cambridge	Sir Hermann Bondi
1987	The Royal Society, London	Sir George Porter
1988	St Pauls Girl's School, London	Mrs H. Brigstocke
1989	Worcester College, Oxford	E.T. Hall
1990	The Savile Club, London	The Editor
1991	Darwin College, Cambridge	G. de Q. Robin
1992	The House of Lords, London	Baroness Brigstocke
1993	Institute of Materials, London	Erasmus Darwin
1994	Christ's College, Cambridge	Dame Anne McLaren

After these 16 years of pleasant perambulation, the new publishers, the Institute of Materials, decided that future Meetings of the Board would take place at lunch time in their own magnificent Nash-designed building at 1 Carlton House Terrace in London.

At all these Meetings, as long as I was the Editor, the proceedings were the same. After thanking the Host, often the Master of the College, I welcomed new Members and special guests from abroad, and reported on the death of Members since the last Meeting. I then spoke about the forthcoming contributions and any Special Issues planned, and finally received suggestions for future articles from the Members of the Board. This led inevitably to pleasant and often very lengthy discussions about the merits of the various proposals. The task of finding appropriate authors was always left to me and was by no mean always successful. The date of the Meetings was always during the middle of the second week of the month of July, mostly on a Thursday.

Looking at my diary after more than 12 years, I was delighted to see that it was a year of great activity and that my travels included a further world tour. Starting on 1 March I flew to New Delhi and on to Madras, where I visited the Leather Research Institute. It was Prime Minister Nehru who had founded it, and not only done much scientific research but its new technology had improved the work and life of the low caste of Indian tanners. It fulfilled Nehru's concept of 'Scientific Temper', to ameliorate through science the conditions of Indian life. From India via Singapore to Townsville in Northeast Australia, where I went to the tropical James Cook University. I had hoped to organise a Special Issue on 'Science in the Tropics', but the expected sponsorship from Thailand did not materialise.

In Australia, I flew to Sydney, Canberra, Melbourne and Hobart in Tasmania, back to Sydney and across the Pacific to Los Angeles. I met my Australian scientific friends and discussed contributions to ISR, as I planned a Special Issue to celebrate the 200th Anniversary of the first settlement in Australia in 1788. I was very successful, the project grew into a splendid Issue, ISR 12/4, entirely devoted to the Australian Bicentennial in 1988, surveying the scientific achievements of 200 years, published in December 1987 [see Title 357].

My visit to the USA brought me into contact again with Members of the Editorial Board, as it had done in Australia. In Los Angeles, I saw Fred Adler whom I first met when the inaugural comsat in geostationary orbit, 'Early Bird' [See Title 108], was launched. I invited Adler to join our Board. As a physicist and Vice-President of Hughes Aircraft Company, his wide interdisciplinary knowledge was most welcome and I was sad when he retired to Hawaii and left the Editorial Board.

From Los Angeles on to Tucson, Arizona, where I first learnt about Dendrochronology; I tried to obtain an article, but did not succeed. I was more fortunate in Austin, Texas, where Hans Mark, another Member of the Editorial Board had become Chancellor of the Texas University System. In his august position, he was able to give me many introductions to senior staff members at different Texan Universities, all of which came under his jurisdiction. As luck would have it, my visit coincided with a great festival which he and his charming wife Marion hosted at his official residence, where I stayed for a few days—a splendid opportunity to learn what real Texan hospitality meant.

After this experience, my visits to Raleigh, North Carolina, to stay with a friend from school days in Berlin, Dr Peter Witt, then Washington and the AAAS in Philadelphia, were relative routine. I returned to London on 2 June, having spent three glorious months, full of science and of friends.

1986—European Travel Title 352

The year 1986 was very eventful—on 28 January the US Shuttle *Challenger* exploded a few seconds after launch from Cape Kennedy. The reason for this first American tragedy in space, seven astronauts killed, was traced to human failure, a faulty 'O' ring having been fitted. [See Title 349]

In February I travelled to Paris to see M. Kadoora at UNESCO to find out if the free issue of ISR to 100 Universities in the Third World could be resumed, as it had proved so successful in the past. It was a unique event which was never repeated for financial reasons. I also saw Dr Salvatori at the Headquarters of the European Space Agency, ESA in Paris, to find out if a Special Issue of ISR about ESA would be welcome [see ISR 13/2,Title 360]. From Paris I flew to The Netherlands where in Noordwijk I discussed this Issue with the Public Relations Department of ESTEC, the Research Institute of ESA.

While in Holland I called on G.W. Rathenau, a Member of our Editorial Board who had been the Director of Philips Research and was distinguished by his exceptionally wide interdisciplinary knowledge and experience. He lived in the small and beautiful community of Aalst-Waarle, ideally suited for his scholarly retirement. It was always a great pleasure for me to talk with this wise, elderly statesman of science and to listen to his many valuable comments.

In June I was in Pisa and Florence to take the Chair at the annual Meeting of the International Astrolabe Society of which I was the President. In July I visited Lindau for the annual Meeting of Nobel Laureates, where I always benefited greatly from their lectures, some of which were published in ISR.

Stefanie Maison and I spent a pleasant holiday in Hinterzarten, in the Black Forest during August, and on the 22 August, my 70th birthday, we were in Würzburg admiring the Tiepolo Frescoes of the five continents in the Residenz. We drove in her Honda Civic all the way and home again to London through Cologne and Mainz to the Hook van Holland and Harwich. However, my most important European visit was to Hanover in December.

For some time I had considered the formation of a New International Association [see next page] which had to be financed. In Hanover, through an introduction from Professor Eduard Pestel, the President of the Leibniz Society, I was able to meet with the Staff of the Volkswagen Foundation there. I had by then written my two Editorials for ISR 12/1 and 12/2, 1987, dealing with "An International Association for the Advancement of Science". These were accepted by the VW Foundation for the financing of an Inaugural Meeting in Hanover in October 1989. [See Titles 353-355]

ISR 12/1 + 12/2 *An International Association for the Advancement of Science* Title 353

For more than 30 years—I wrote in 1987—I had been in the uniquely privileged position of regularly attending the three Meetings of the American and British Associations for the Advancement of Science, as well as the Gesellschaft Deutscher Naturforscher und Ärzte. In my opinion these three Organisations, and similar ones in other parts of the world, as for example the Indian Science Congress Association which I attended in Bangalore in January 1987, all basically face the same difficult problems. I thought it highly desirable, therefore, to create a new forum where their problems could be discussed and solutions be attempted. I advanced a plea for closer links of the new Association in the first volume of ISR, 1976, ISR 1/4, and called it the "Cultivators of Science" [see Title 266].

The functions of an *International Association for the Advancement of Science*, IAAS, which I proposed in ISR March and ISR June 1987, should be:

- To make politicians and the public understand the significance of science in the peaceful progress of mankind, the Scientific Temper.
- To attract again the elite of young persons to scientific careers.
- To counter unjustified criticism of science.
- To provide a forum for each of the constituent National Associations to exchange their experiences with their sister Associations.
- To infuse the international Spirit of Science into the often nationalistic and parochial meetings of the national organisations.

It must appear extraordinary to urge the oldest scientific organisations in Europe and the USA to form themselves into a new international Union. (The oldest is the German Gesellschaft, founded in 1822; the British Association held its first meeting in York in 1831 and the American Association for the Advancement of Science dates from 1848).

After all, scientists belong to the most international of all professions. International co-operation in scientific research, irrespective of language, race, creed and sex, has always been the pride of scientists. Furthermore, almost all individual scientific disciplines, whether chemistry, physics, biology or astronomy had formed their own international Unions, all of which are united in the International Council of Scientific Unions, a powerful but little known body.

The meetings of the National Associations are now no longer essential for learning about the latest advances in one's own discipline. For today's scientist they have become a luxury for pleasant social gatherings in their crowded scientific calendar, enjoyable, but not imperative, although their many interdisciplinary contacts have always advanced science greatly.

In my second Editorial dealing with the need for an International Association for the Advancement of Science, I repeated briefly the five main functions and then criticised the four Meetings I attended in 1968. I found that the AAAS in Philadelphia had only attracted 2700 members of its total membership of more than 133000, and asked if science had lost its attraction—as in previous years the attendance had regularly been in excess of 10000. With 1500 speakers and 21 symposia, no richer offering could have been presented to the 500 representatives of the media for whom 22 press conferences had been organised, on the hour—every hour. If only 2700 members attended, at least millions of newspaper readers and television viewers benefited.

The British Association Meeting in Bristol was attended by 1700 members, among whom were a large proportion of senior school pupils from all over Britain. They belonged to the 'British Association of Young Scientists', the BAYS movement, organised as clubs in the best schools of the country. To me this was the most valuable contribution to an IAAS, to be repeated by all other National Associations and the greatest hope to attract once again the elite of the young to the excitement of a scientific career. At the special BAYS lectures one could hardly see any adults.

At the biannual meetings of the GDNÄ, only one lecture is offered at a time, and in consequence audiences number several hundred, whereas at the AAAS and the BA only 10 to 100 hear a speaker. At Munich the lecturers often indulged in lengthy historical introductions and then had little time left for the latest developments in their subject.

In Bangalore at the Indian Science Congress Association, the most impressive feature is the continuing tradition of a keynote address by the Prime Minister. Begun by Nehru in 1947, in 1986 it was Rajiv Gandhi who delivered a stirring message to the 3500 members, promising more money for science and calling for a campaign to improve the standards of science, to rid itself of mediocre practitioners, of its bureaucracy and of its vested interests. Never before had I heard a Prime Minister deliver an address, let alone a critical one, to a Meeting for the Advancement of Science. I can only recall the occasion when Hubert Horatio Humphrey, Vice-President of the United States of America, addressed a controversial lecture to the AAAS, to be promptly pelted with eggs and tomatoes. Speeches by senior Government Representatives would no doubt be welcome at other Associations, and need not be followed by insulting missiles.

This particular AAAS meeting addressed by Vice-President Humphrey was also memorable for a second reason. When leaving it at the end, I noticed a number of gentlemen in business suits among the generally informal attire of scientists. On closer inspection I found that all of them had a bright blue button in their left lapel which I had never seen before, and I asked one of them which new scientific society the button represented. "No, Sir, I am a member of the US Secret Service, and the button identifies me, so that when the shooting starts, we do not fire at one another". (In the USA, the Secret Service guards the lives of the President and the Vice-President and also tries to prevent the counterfeiting of the national currency.

Acting as the Convener, it took me over two years to bring about an Inaugural Meeting, following the publication of my two Editorials in ISR in 1987. The German Volkswagen Foundation made a grant of DM 40000 available to the Leibniz Society in Hanover, and I worked closely with Professor E. Pestel, the President, and Dr W. Totok, the Secretary of the Society, to organise the Meeting. The Leibniz Society had its seat at the Landesbibliothek in Hanover, and its secretarial staff carried out the preparatory work of sending out invitations to all known Associations world-wide. I was glad that G.W. Leibniz (1646-1716) was linked to this endeavour, as in the 17th and 18th centuries he devoted much effort to the foundation of scientific academies, as for example the Berlin Academy.

Nine different Associations sent delegations for the Meeting which took place from 2 to 5 October 1989 in Hanover at the Hotel Luisen Hof. They came from Australia, Bangladesh, Britain, China, Germany, India, Japan, Sri Lanka and Venezuela, and it was necessary to pay their air fares as well as hotel accommodation and meals. This exhausted the grant, as some Associations had sent more than one representative.

I asked Lord Dainton FRS to take the chair, the first mistake I made. I should have taken the chair myself. I doubt whether Lord Dainton, however excellent a chairman he proved to be in Hanover, considered the chairmanship as anything more than a single task and he was basically not convinced that IAAS was a worthwhile and permanent enterprise. My second mistake was to let the whole grant evaporate through air fares and the luxury of a five-star hotel. At least half the grant should have been available for follow-up work.

The Meeting agreed unanimously to a resolution that the IAAS should be founded and a draft constitution was passed in which the functions of the IAAS were defined, substantially those which I suggested in my Editorial [see Title 353]. The British Association was to take over all further work, as I personally felt unable to devote more money, time and effort, my third mistake. [See ISR 14/4, p. 329, where a brief report was published]

I was not invited to any further meetings. In 1991, the next reunion took place in Hong Kong where the name was changed to International Federation of Associations for the Advancement of Science and Technology, IFAAST, and in 1994 the AAAS published a Membership Directory, of the names, addresses, officers, principal activities and publications of a total of 34 Associations. I never received a copy. In the Preface to the Directory it was stated: "The IFAAST is the realisation of a Vision". I was pleased to be told this, but sad that I had not been asked to participate.

ISR 12/3 A.C. Clarke *Star War and Star Peace* Title 356

In November 1986, Arthur C. Clarke gave the 19th Jawaharlal Nehru Memorial Lecture in New Delhi in which he named as his text his prophesy of 1946: 'The only defence against the weapons of the future is to prevent them ever being used. The problem is political and not military. A country's armed services can no longer defend it; the most they can promise is to destroy the attacker'. As a personal friend, I was privileged to publish this detailed analysis, delivered during the period of the Cold War.

By 1987 the number of nuclear warheads in the world was 50000, leading to the concept of 'Mutual Assured Destruction'—so aptly abbreviated as MAD. Trying to convey how this preposterous, obscene situation arose, would be "an expense of spirit in a waste of shame". Instead Clarke tried to picture the result of using this mega-tonnage of atomic destruction by comparing it with the total destructive forces of World War II, employed once a second during a "lazy afternoon". A Nuclear Winter would follow atomic war, when the few survivors could no longer grow any food on the deserts of fused glass.

The interception of Intercontinental Ballistic Missiles, ICBMs, is ruled out as only during the initial ascent of the rocket could another missile, travelling at the speed of light, destroy it. Any later destruction, during its flight to the target, would be too difficult. As an alternative, 'orbiting fortresses' equipped with super lasers, which might fuse the attacking ICBMs, were proposed in the Star War scenario unleashed by President Reagan in his March 1983 speech and later elaborated as the Strategic Defence Initiative, SDI. This concept was again under discussion from 2000 at a political level in the USA. [See Title 356A]

As the Soviet Union ceased to exist after 25 December 1991, Clarke's further technical descriptions of Star War weaponry have become only of historical interest. Still to come, however, are Clarke's 'Peacesats', satellites watching the whole Earth from space on behalf of an International Monitoring Agency, as President Giscard d'Estaing of France first suggested in 1978. Their photographic reconnaissance could verify arms control agreements, check border violations, and defuse crisis situations, in fact act as watchdogs for the whole world.

To conclude his Nehru Memorial Address, Clarke recalled some words from his 1984 speech at the Pontifical Academy when he mentioned the dynosaurs who tried to protect themselves with ever more cumbersome armour until they were walking fortresses. They never noticed the little creatures that skipped out of their way, the first mammals—our ancestors. "Intelligence, not armour, was to inherit the Earth. May it do so once again."

A Pearl Harbour in Space — Title 356A

After the peaceful Clinton era, the SDI concept, also known as 'Star Wars', was politically resurrected by President George W. Bush soon after his election in 2001. This time it was named National Missile Defence Shield, NMDS, just Missile Defence, MD for short, and officially envisaged as a local defence against missiles, containing either atomic or C B W weapons. [See Titles 159-162]. They would be launched towards the USA, it was speculated, by 'rogue states' which had acquired primitive rockets. It was publicly described as 'hitting a bullet with a bullet'. In the period between SDI and MD, no convincing demonstration of such a theoretically possible defence had been offered, although it was attempted by the USA Defence Forces. By the time of going to press (July 2001) a 'friendly fire' success could be announced. It proved that indeed two electronic bullets could hit each other in space, if both orbits were pre-determined by the same computer—unlikely in case of war!

There was immediate opposition to the NMDS by Russia and China, fearing it as the first step towards a militarisation of space, which had so far been a taboo subject. More realistically, it was considered as the beginning of a new arms race. In the USA, opponents of President Bush saw MD as a typical 'pork barrel' operation, repaying the space-military industrial complex by massive. MD research grants over many-years for its lavish contributions towards President Bush's lengthy and expensive election campaign and the heavy legal fees arising from it

The second step in the militarisation of space was announced in Washington on 8 May 2001 by Mr Donald Rumsfeld, the USA Minister of Defence. He proposed a military strategy in space a completely novel development, never before officially advocated by any sovereign state. Admittedly, the girdle of synchronous communication satellites round the Earth at a height of 36000 km offers a tempting target to any hostile state, as their destruction and those of the reconnaissance satellites of the USA would be a serious defeat if any space war developed. Rumsfeld called the USA "an attractive candidate for a Pearl Harbour in Space" and advocated the creation of a Military Space Force.

For the defence of information and communication satellites, only powerful laser beams are at present under consideration, but not yet available in space. *Si vis pacem, para bellum* will be as true in space as on Earth and in Rumsfeld's report to Congress, the creation of new weapon systems were urged, for attack, as well as for defence in space. But opposition in the US Senate and by NATO in Europe, as well as from other States, may yet prevent this highly undesirable extension of US warfare into space.

ISR 12/4 *Australia's Bicentennial* Title 357

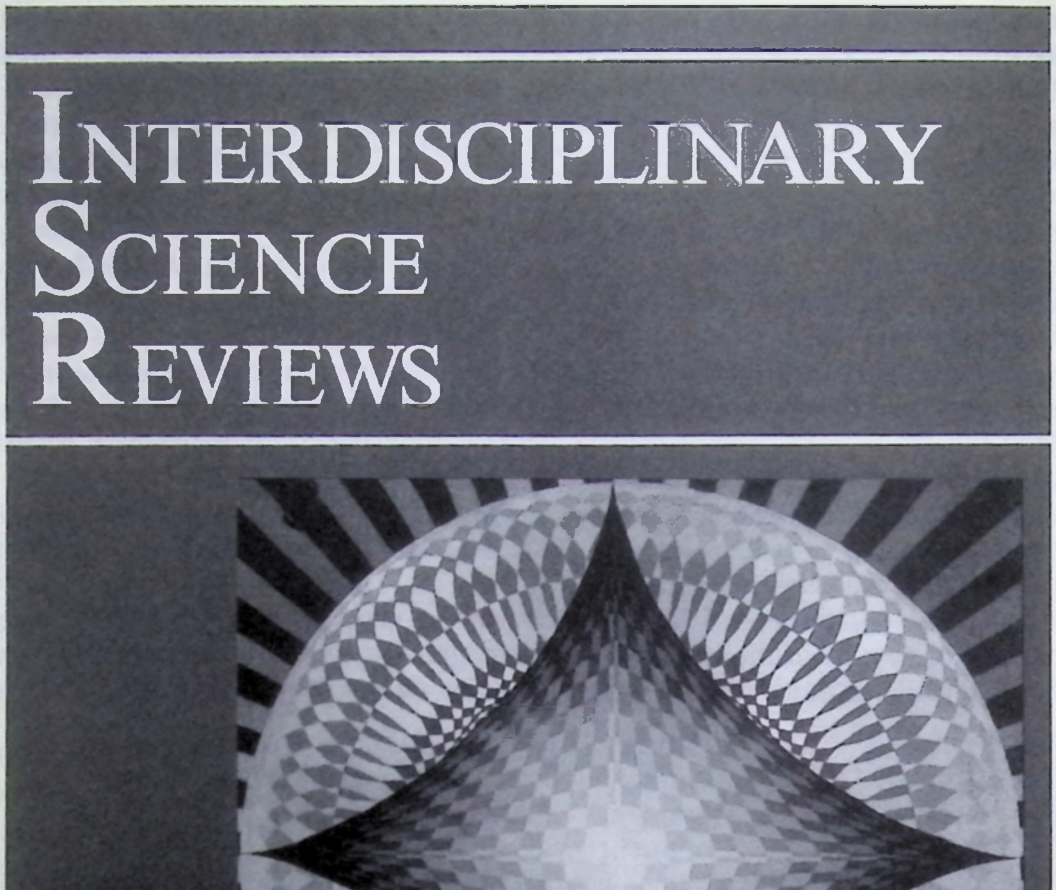
I know Australia fairly well, perhaps a little better than most visitors. I had lived there from 1950-1954 [see Titles 44-59] and had travelled widely to its scientific and technological attractions in 1966 [see Titles 128-134]. Again in 1969, I had a chance to see the extreme north of Queensland [Title 192] and on my round-the-world travels I had always included Canberra [Title 316] Sydney and Melbourne. My family, ex-wife, two daughters and four grandchildren live there, and I had made many friends among Australia's senior scientists.

I had of course prior knowledge of the Commemorations planned for 1988, and as I had been much impressed by Australia's progress during the nearly 40 years I had known it by 1987, I decided to devote a Special Issue of ISR to its interdisciplinary science. The official date for the 200th Anniversary of Australia's Bicentennial was 26 January 1988, two centuries after Captain Arthur Phillip of the First Fleet hoisted the British Flag at Sirius Cove (now a smart part of Sydney where I had lived for three years), where he founded the first settlement of 736 convicts, 573 men, 163 women, and 250 free persons, mostly marine guards. By the time of the Bicentennial, the Australian population had grown to over 15 million of which 1.5%, 230000, were aborigines.

In selecting contributors, I had to be guided by my personal knowledge of experts, and I knew from the beginning that I could only publish a selection of Australian scientific achievements. The total contents of this Special Issue was:

A.R. Michaelis	Editorial—Australia's Bicentennial
G.B. Gresford	Comment —Science Policy in Australia
H.W. Arndt	Comment —Australian Economics
J.A. Birch	Comment—Chemistry in Australia
J. Simons	Biology in Australia: Its History and Successes
R.S.F. Campbell	Science in Tropical Queensland
Justice M.D. Kirby	Human Rights—The Challenge of New Technology
Rhondda E. Jones	Evolution and Creationism
C.M. Crawford et alii	The Mariculture of Giant Clams
J.H. Carver	Peaceful Uses of Outer Space
D.G. Keith	Cuspation: Present and Future Applications
A.R. Michaelis	Australia's Scientific Banknotes

I hoped in my Editorial that even this small selection would help to bring some scientists from Europe and the USA closer to their colleagues in Australia, as in spite of modern air travel, Australia had remained a distant and relatively seldom visited Continent. This Special Issue of ISR was not sponsored by any official or industrial body.



Title 358

A point on a small wheel's cicumference, running inside a fixed wheel with a four-cusped diameter, describes a star-shaped astroid – an oil-painting by Dr Hans Hillmann, physicist and painter, for the cover of the ISR Special Issue of 1996.

Special Issues of ISR 1978-1996 Title 358

I published a total of 17 special issues during the 20 years I was Editor of ISR, an average of almost one every year. However, there was no regularity in their appearance, and I edited one whenever a suitable subject appeared to be on offer. Alternatively, the accumulation of several related manuscripts suggested an expansion of a theme which could be combined to form a special issue. I had as my prototype the Indian Journal *Seminar,* devoted totally each month to a single political or economic, but not a scientific, issue. It was edited by my good friend Romesh Thapar and after his death by his wife Raj and after her death, now by their daughter Mala Singh.

There have been two kinds of Special Issues of ISR, Sponsored (S) and non-sponsored, depending on subject and opportunity:

ISR	4/1	Science Policy
	4/3 S	10 Years after the first Moon Landing
	5/1	Biotechnology and Nutrition
	6/1	The Diverse Sea
	7/3	Agriculture: Its Evolution
	7/4	Science and Politics
	8/1	Electronic Information
	9/1	Perception
	9/4 S	Heavy Ion Research
	11/2 S	600 Years University of Heidelberg
	11/4	Disasters
	12/4	Australian Bicentennial
	13/2 S	European Space Agency
	14/3 S	25 Years German Cancer Research
	15/4	Joseph Needham 90 Years Old
	17/3 S	Gold: Art, Science and Technology
	17/4 S	Focus on Gold
	18/3 S	Interdisciplinary High Technology at Karlsruhe Nuclear Research Centre
	21/4 S	Man—Environment—Technology: Interdisciplinary Science Support by the Gottlieb Daimler and Karl Benz Foundation

It was always difficult to find a Sponsor and equally difficult to find the right subject for the Sponsor to support. The conditions for a Special Issue were therefore simple: A minimum of 5000 copies at a price of £ 5 had to be ordered from the publisher, who was prepared for that price to deliver the copies of the Journal free of charge with two colour covers, front and back.

Sponsorship for a single issue of a scientific Journal was a successful new idea.

ISR 13/1 *The Legacy of Lesseps: A School of Engineering and Diplomacy* Title 359

I met Frank Davidson in the late 1970s, at a Meeting of the AAAS where he introduced me to the concept of 'macro-engineering', about which he contributed an excellent Comment in 1984. [See Title 327] I liked Frank from the beginning, because of his wide interdisciplinary spirit, although, or perhaps because, he had trained and worked as a lawyer in New York. When I met him he was lecturing about, and researching in, the Macro-engineering Research Group of the Massachusetts Institute of Technology, living half the year in Concord, Massachusetts, and the other half in Paris. His outlook on life could not have been more international.

As our friendship grew during frequent meetings on both continents, I asked him to join the Editorial Board of ISR, and in 1988 he contributed another Comment, analysing the Club of Rome's problématique from a deep engineering and political-diplomatic point of view. He concluded that only the foundation of a School, devoted to teaching engineering to diplomats, and to instructing engineers in the finesse of diplomacy, could correct the present inability of decision-makers to apply available macro-engineering solutions to the great problems of the world. This was the legacy of Lesseps, the diplomat, who created the greatest engineering achievement of the 19th century, the Suez Canal.

Like Frank Davidson, I have always admired this great engineering feat of the Suez Canal, whether I travelled by ship to and from Australia or on that unique occasion on 16 November 1973 when I crossed the Canal in an Israeli military transport carrier over a temporary Bailey Bridge, while a section of the Suez Canal was occupied for a short time by the Israeli Army.

A Post-Graduate Academy for Engineers and Diplomats would have a plethora of past, present and future potential subjects to deepen and broaden the perception of its students, wrote Davidson. He mentioned a few, like the recurrent droughts of the Sahel, the building of artificial islands perfected by the Japanese, a world-wide electricity network, a planetary water supply grid and supersonic transport through vacuum tubes underneath the Atlantic Ocean.

The technology for these projects is now, or will shortly be available, according to Davidson. Is our era really incapable of moving beyond conferences and casual alms-giving to groups desperately in need of rehabilitation and re-establishment, when engineering on a grand scale, *les grands travaux*, could contribute so much? To adapt diplomacy to the requirements of engineering was highlighted in this Comment by the educational dimensions of the task, possible perhaps through Nakajima's Global Infrastructure Fund.

I met Professor Reimar Lüst when he was the President of the Max-Planck-Society in the early 1980s and on his suggestion wrote "Recovery of Science in Germany" [see Title 303]. Following his appointment as Director-General of the European Space Agency (ESA) in 1984, I kept in touch with him at his office in Paris, and as a result the special issue was sponsored by ESA.

My Editorial was devoted to "Partners into Space", praising international co-operation in all aspects of space exploration. I had written a letter to *The Times* in London on 14 August 1958, less than a year after the Launch of the first Russian Sputnik (4 October 1957), urging international co-operation in space, as no single country would alone be able to achieve more than local success. Apollo proved me right, (because the Moon can be considered as local in this context), but international and interdisciplinary teamwork will always be needed if deep space is to be explored, and I therefore welcomed the formation of ESA in 1964, the first step to an International Space Agency. An International Space Station is now getting ready in orbit, another "small step for a man".

The second Editorial was written by Reimar Lüst "Space Panorama —Europe's Future Programs. To him the heart of ESA will always be the Space Science Program, consisting of four cornerstones: Solar-Terrestrial Physics, X-ray Astronomy, the Heterodyne Spectroscopy Mission and the Primitive Bodies Mission, as for example the Giotto Mission to Comet Halley which was so successful in 1986. In addition, scientific satellites were to be built by ESA, the Ariane-5 launch rocket was to be developed and the Agency was to increase its application programs, especially in telecommunications and the remote sensing of Earth Resources. These many activities were explained in:

R.W. De Korte	Europe's Political Will for Space
R.M. Bonnet	Horizon 2000—Updating the Plan and its Progress
R.Z. Sagdeev and R. Reinhard	International Co-operation: IACG
R. Reinhard	Halley's Comet—Its Secrets Revealed
S.A. Hempenius	How Europe could best use Remote Sensing Programs
K.H. Stewart	Satellite Observations for Weather Forecasting
K.E. Klein	Biomedical Research and Application in Space: Status and Perspectives of European Activities
E. Vallerani	The Space Station
F. D'Allest	The Ariane Family
B.R.A. Burns	HOTOL, an Economic Space Transport for Europe
J. Feustel-Büechl	The European Space Plane *Hermes*: Future Transportation

Four full-colour pages with 20 photographs gave the Issue a special flavour.

"To vote a monnyment to a man" may have been easy in the past, but to find a Monument for the Third Millennium proved impossible as Dr Roger Malina, the Executive Editor of *Leonardo* and I found out, when we issued a joint invitation to our readers to suggest a suitable Monument, as early as 12 years before the event. Few suggestions came to our Editorial Offices—none worthy of serious consideration.

We were both sadly disappointed, as we thought we had given our readers clear instructions and even suggested a number of possible themes. As a worthwhile Monument, either physical or spiritual, would in our opinion take about 10 years to realise, we decided it was not too early to publish our invitations in 1988.

Our specifications were clear: The Monument, either material or nonmaterial, must be forward-looking and designed to survive at least 500 years. It must be global in concept, understandable and accessible to people from all over the world. It is to commemorate the survival and the ever-expanding horizons of mankind, our achievements in the arts, in the sciences and technology. The Monument should project the hope for a world in which our descendants will look back on us, the millennial generation, as one which took conscious responsibility for the future of the planet and its inhabitants.

We gave examples of precedents to a Millennium III Monument. For example, Andrew Carnegie's gift of public libraries at the beginning of the 20th century was an excellent way 'to vote a monnyment to a man'. One might suggest today a Global Electronic Library, like the Internet, which would perhaps come within our specifications. A more material Monument we suggested, would be the reforestation of denuded areas of our planet.

We also suggested a New Institution, like the Smithsonian, which is devoted to the 'increase and diffusion of knowledge'. The New Institution should adopt as its motto: *The use and application of existing knowledge for the improvement of the human condition.* This might lead to a 'global educational interactive television or communication network' we wrote in 1988, and this very idea came to fruition through the Internet! Perhaps, writing ten years later in 1998, it could be named the 'Millennium Internet' and thus act as a proper Monument, fulfilling all specifications set out above.

We had thought out and published detailed judgment procedures if many suggestions had been submitted, but of course these were never activated.

At the Dinner of the Editorial Board in July 1988, which took place at St Paul's Girls School, London, the suggestion was made that the 'Great Challenges at the end of the Millennium' should be discussed in the Editorial Columns of ISR. It was a splendid dinner at the invitation of the High Mistress, Heather Brigstocke, later the Baroness Brigstocke. Members of the Editorial Board were to write about the Challenges, but none did.

I felt bound to open the Discussion with the Challenge which I had for many years considered the greatest, the 'Human Breeding Storm'. I had written about it as long ago as 1962 in the *Manchester Guardian* and was very proud when my big article was reprinted later in the *San Francisco Herald.* In my Editorials in ISR, I had often warned that two major challenges faced mankind at the end of the 20th century, the Population Explosion and the Atomic War, and if not solved, the one might solve the other. I repeated in 1988 the need for halting the human breeding storm, which in the last decades had risen to a hurricane. The only valid solution I could offer in my Editorial was global education by satellite, like the short-lived experiment carried out in 2400 Indian Villages in 1979 with great success [see SITE,Title 277].

At a dinner party in New Delhi, I had met Sri Madhava Ashish who analysed the Indian population explosion for me in interdisciplinary terms, and I asked him to contribute. Ashish was a British officer in the Royal Air Force, who after the end of World War II stayed on in India and became the head of an ashram in the Kumaon hills in Uttar Pradesh. He had made great contributions to Indian environmental education, at first on local, and since 1980, on national levels as a Member of the New Delhi Planning Commission.

With the forecast that the Indian Population would reach 1000 million by the year 2000, (which it did) Ashish blamed Indian politicians for not giving high enough priority to this question, as they feared a loss of votes. Neither vasectomy nor tubectomy were the answer, nor was economic growth available to reduce the number of children as it had done in Europe, because old-age security-conditions in India were too different.

A contrary contribution on Population followed from Dr Karan Singh, who considered 'Development the best Contraceptive'. Karan Singh whom I met at the same dinner party, was the Former Maharaja of Jammu and Kashmir and was Minister of Health and Family Planning under Indira Gandhi 1967-1977. He had been responsible for the National Population Policy in 1967 but blamed its failure on overzealous implementation and, later on, a tepid revival. He was convinced that living standards were lowered by the growth of populations, but would bring about only greater economic development a lower birth-rate .

1988 was another 'Three—Association—Meetings—Year' which showed me how necessary it was to establish an International Association for the Advancement of Science. In February I attended the AAAS Meeting in Boston, in early September the British Association Meeting in Oxford, and in the middle of that month the Meeting of the Gesellschaft Deutscher Naturforscher und Ärzte in Freiburg.

All three proved routine, with many interesting lectures, a few outstanding ones, and even one or two full of interdisciplinary interest which I tried to win for publication in the Journal. One general criticism applied to all: The presentation of visual data, whether through view graphs or slides, was as appalling, as usual. If as little attention had been paid to the preparation of research data, as had invariably been devoted to the presentation of visual data, science would have come to a halt long ago. This criticism is also true of the Nobel Laureates, lecturing annually at their Meetings in Lindau. [Title 379]

In 1991 I asked an expert, Professor Charles Engel of the Center for Higher Education Studies at the Institute of Education of the University of London, to write a scathing comment on this subject "You Won't Be Able To Read This, But ..." in which he pointed out that the remedies for the illegibility of slides and view graphs—were well known. Projected images depend on contrast and if this is insufficient, or the projected text is too small, little is communicated.

Furthermore, the clarity of the message shown on the screen is equally important, and if the visual curiosity of the audience is concentrated on the deciphering of the projected image, it will detract from the spoken word of lecturer and hence he will make little contact with those who came, anxious to his message. Engel's admonition appeared in print in ISR 16/2, page 120 (1991), and I gave reprints to those who were guilty of this arrogant disdain of their audience. I doubt whether this had a general effect, although I imagine that the embarrassed recipient of the reprint might have taken it to heart.

If a lecturer claims that he needs an expert for the preparation of his visual aids, he may be fortunate in having such an expert on the staff of his university or his industrial company. Whenever I attended a presentation by a military lecturer, I must admit that they could not be faulted. Their size of lettering, their brief and clear messages came across easily, and in this respect scientists have much to learn from the military.

Engel cited 10 publications giving detailed instructions on the preparation of visual aids, and among them I have always found E.R. Tuft's excellent *The visual display of quantitative information*, 1984 Graphic Press, the best.

Ten years later in 1998, I asked myself the question: Was 1988 in any aspect an unusual year for the world or for me? More for the World than for me! The ascent of Mikhail Gorbachev to become President of the USSR and his decision to withdraw troops from Afghanistan and later from Hungary and East Germany, were the first signals indicating the end of the USSR, but were then not understood. In June two million black workmen held a three-day general strike in South Africa, protesting against the apartheid laws, action that led to the end of racial discrimination. At the XXIV Olympic Games in Seoul, Ben Johnson won the 100 meter race but because his drug-taking was discovered, his gold medal had to be returned. This led to much stricter anti-doping laws.

Were these events a foretaste of things to come? Perhaps more than the earthquake in Armenia, which destroyed the town of Spitak with 55000 dead. More than the terrorist bomb which exploded over Lockerbie in Scotland inside a Boeing 747 Pan Am flight which resulted in 258 dead, then the worst aviation accident in Britain. Or the death of 50 miners in a German brown-coal mine? After 10 years, these three disasters can only be considered as normal events in the long-term flow of history.

My own life during 1988 must also be judged as normal. I travelled widely, in February to Washington, Boston—AAAS, and New York, which I had often done before, and this brought me new articles for publication in ISR. In the same month I visited the Dutch Delta works against flooding, and I was most impressed by their macro-engineering effort, then nearing its successful completion [see Title 365]. I had fun in June when friends took me to the famous 24-hour motor race at Le Mans and I enjoyed participating at the Club of Rome Meeting in Paris in October, where I met old friends from India, Romesh Thapar as well as Dr Karan Singh and his beautiful wife.

Later that month I was again in India and in Australia. In Melbourne I got to know Dr David Solomon of the CSIRO Division of Chemicals and Polymers who invented the Optical Variable Design, OVD, incorporating it in banknotes to make them practically unfakable [see ISR 14/4, page 399]. He explained to me his 10-year research effort, which in my opinion was a most brilliant example of interdisciplinary science and technology, as the Australian $ 10 banknote proved. I was proud to publish the first scientific account of this in ISR.

I returned from Australia via Hong Kong and India, where in New Delhi I saw the construction of the new beautiful Bahai Temple by local labour on bamboo scaffolding. Its huge white vaulted roofs can only be compared with those of the Sydney Opera House, which needed computer-controlled technology.

The term 'macro-engineering', first used by Frank Davidson and explained theoretically [Title 327], has always excited me as I have had the chance to see several examples, and it stimulated my historical curiosity. My visit to the Dutch Delta made me think historically, as The Netherlands had often suffered in past centuries from disastrous flooding of their country.

A number of human endeavours in prehistoric times deserve to be called 'Macro-Engineering' such as Stonehenge, although we still do not know the precise manner in which it was constructed. First accurately surveyed and described are the Egyptian Pyramids, followed by the great Roman civil engineering works like aquaducts and cross-continental roads. In the Middle Ages, the Gothic Cathedrals [see Title 271] and other great places of worship were masterpieces not only of construction, but also of the provision of building materials (millions of bricks) and their transportation to the site.

In the 19th century the Suez Canal, and in the 20th the Panama Canal deserve to be included, followed in more recent times by the separation of uranium isotopes for the manufacture of Atomic bombs and the spectacular Apollo flights to the Moon. The mastery of constructing nuclear submarines is also a great macro-engineering achievement, and these will now serve for oceanographic exploration, as Jules Verne foretold more than 100 years ago. *National Geographic* in March 2000 published the first non-secret report that a nuclear submarine, the USS *Hawkbill,* had carried out extensive oceanographic and meteorological research and data acquisition work in the Arctic Ocean, much of it below the ice. Although secret, naval under-ice surveying work was routine since the USS *Nautilus* reached the North Pole submerged in August 1958, 42 years earlier, it was only in March 2000, that this research was de-classified, and another scientific prediction was fulfilled.

In Europe, the Channel Tunnel [see Title 247] and the Dutch Delta Project [see Title 225], both now completed, were examples of great macro-engineering achievements, and I was fortunate enough to watch them in progress and record them in ISR. To me, the grand scale and the precision of these two, were eloquent proof that macro-engineering need not have the resources of a Superstate to be implemented. If there is careful planning, and sufficient time for their completion, and if the raw materials can be assembled over lengthy periods, if the special machinery for tunnelling can be procured without having to design and manufacture it, then macro-engineering projects can be undertaken and completed successfully by states, like England, France, The Netherlands and Japanese bridge and tunnel engineers, always provided that Professor R.T. Seaman's ideas expressed in *Shared Characteristics of Large-Scale Endeavors* [see Title 164] are followed in a free and democratic society.

Title 366

Lord Porter FRS, Nobel Laureate 1967, a Member of the ISR Editorial Board, is Britain's most distinguished lecturer about science, seen here at his best at the Royal Institution, of which he was the Director. *Courtesy Lord Porter.*

I attended the 16th Annual Richard Dimbleby lecture held at the Royal Institution, Albemarle Street, London, on 10 April 1989; it was founded by the BBC to commemorate Dimbleby, one of Britain's greatest communicators. In 1989 the lecture was given by Sir George Porter, an outstanding lecturer, television and radio broadcaster of highest professional standard, so seldom achieved by a great scientist. These qualities had been recognised by the award of the Kalinga Prize from UNESCO, the highest distinction for a scientist who also excels in communicating his subject to a non-scientific audience.

I knew George well and greatly admired him; I invited him soon after the foundation of the Journal in 1976 to become a Member of our Editorial Board, which he accepted. His distinction as a physical chemist was of the highest, even greater than his fame as a communicator of science. He was elected President of the Royal Society in 1985 and received the Order of Merit [see Title 320] in 1989. By 1995 he had been elected a Member of 15 Foreign Academies, received 34 honorary Doctorates from Universities, and to crown it all, had received the Nobel Prize in Chemistry in 1967. Until the death of Lord Todd in January 1997, Lord Porter, created a Life Peer in 1990, was Britain's second most distinguished chemist, as Lord Todd had been elected a Member of the Order pour le Mérite [see Title 319] and had a pub named after him, "The Lord Todd".

The BBC which had organised the Dimbleby Lecture by Sir George Porter, as he was still to be called for another two years, had invited a most distinguished audience to the Royal Institution, of which Sir George had been the Resident Professor and Director since 1966. Known as a great admirer of Michael Faraday, his predecessor as Director at the Royal Institution in the 1830s, Porter contrasted Faraday's successful devotion to pure science with its neglect in Britain in the late 1980s, leading to a decline of applied science with dire consequences to the country as a whole.

Power comes from knowledge, and a basic knowledge of science was now needed by all. The introduction of a core curriculum in which science along with mathematics and English is taught to all children up to school-leaving age, the only recent government initiative, was welcomed by Porter. He concluded by drawing attention to the power of television, Dimbleby's, favourite medium and its role in communicating science to children and its contribution to the public understanding of science. Science had given us all a higher standard of living without servitude to others—Michael Faraday and James Watt freed more men and women from Slavery than Abraham Lincoln—Porter triumphantly concluded his outstanding address. An outstanding example of the Scientific Temper.

1989 was declared the European Year of Information about Cancer, and at the same time it was the 25th Anniversary of the German Cancer Research Center in Heidelberg. A Special Issue about Cancer was an obvious subject, as the German Institute had offered to contribute many articles and to distribute a large number of copies. However, the great difficulty remained for me to write an intelligent Editorial about Cancer, a subject about which I knew fortunately nothing. I therefore considered the great human diseases historically, how many had, through devoted medical and scientific research, been investigated and finally cured. I might thus be justified in forecasting that if the same effort was applied, it would also lead to an eventual cure of cancer—in fact my Editorial was a declaration of faith in the Scientific Temper.

I briefly outlined the large contemporary cancer research effort world-wide, and its great interdisciplinary character, the 'bio-psycho-social approach', with its massive human Genome map search. I compared this macro-research with Robert Koch's single-handed discovery in 1882 of the tubercle bacillus and a few years later, of the *Vibrio cholerae*, the causative agent of cholera. The cures for both are well known today, and the same is true for bubonic plague, malaria and yellow fever. Now massive treatment depends more on political, economic and social factors than medical and scientific knowledge. The greatest success story so far in medicine is the total eradication of smallpox, achieved in 1979 by the 12-year long WHO Eradication Program.

Although cancer represented a totally novel challenge, our medical and scientific research instrumentarium had grown out of all recognition in size and diversity during the last century, so that I felt justified in my faith, forecasting the eventual conquest of cancer.

I had been present 18 years earlier, in June 1971, when the building of the Deutsches Krebsforschungs Zentrum, DKFZ, was nearly completed. Its initiator, Professor K.H. Bauer, then 81, showed it proudly to a group of British Science Writers and explained that the seven-floor concrete structure would soon house 800 scientists and have its own atomic reactor, to prepare for research and therapy on site its own short-lived isotopes.

Professor Bauer said that the building would cost DM 62.5 million, of which the Federal Republic would pay two/thirds and the remainder would come from the state of Baden-Württemberg. The research policy would be very wide in the nine Institutes, as no one could predict which branch of science would find the answer. I found it all very impressive, too impressive perhaps, a giant 'white elephant', but of course only a factual report was written and published in the *Daily Telegraph* of 7 June 1971.

Professor K.H. Bauer, had he lived, would have been delighted to celebrate the 25th Birthday of the Institute he had created. By 1989, the Center employed 1500 people, among them more than 300 senior scientists and postgraduates as well as almost 200 graduate and undergraduate students. Its annual budget in 1989 was DM 140 million, with DM 100 million from the Federal Ministry of Research and the remainder from the Land Baden -Württemberg, the German Research Association, (DFG), and from a number of other Foundations.

In 1975 the DKFZ was incorporated as one of Germany's famous National Research Laboratories, and Professor Dr Harald zur Hausen was appointed as the Chairman of the Centre's Managing Board of the Krebsforschungszentrum in Heidelberg. It was by no means a smooth path during those 25 years to achieve world rank, and numerous obstacles had to be overcome. But due to the great scientific ability, the administrative skill and engaging personality of Harald zur Hausen, final success came as the recognition of being one of the world's Centers of Excellence in its field. I had often been a personal witness to its growth pangs and was therefore happy to produce the special issue of ISR in September 1989 which bore such eloquent testimony to the Center's eminence.

The Issue began with Congratulatory Messages from Dr Heinz Riesenhuber, the Federal Minister of Research and Technology in Bonn and was followed by Anniversary Greetings from Professor Dr Helmut Engler, the Minister for the Sciences and the Arts of the Land Baden-Württemberg in Stuttgart. The principal article, which followed my Editorial and the Congratulations to the 25th Anniversary, was the contribution by Harald zur Hausen on "Growth of New Knowledge in the Con-epts of Carcinogenesis". The description of the role of viruses in specific human ancers was one of the focal points in the article. Another important new field of dvance was described by Hilke Stamatiadis-Smidt, the Head of the Office of Press and Pubic Information. Her merit is the 'telephonic cancer information service' allowing members of the public to obtain medical information about progress in their personal cancer therapy. It has been internationally imitated.

The 125-page issue, the second biggest ever published, contained articles about "Genes and Chromosomes in Cancer", "Growth Control of Lymphocytes", "Chemical Carcinogenesis", "Environmental N-nitroso Carcinogens", "Cancer of the Colon and the Rectum", "Human Immunodeficiencies", "Imaging Methods in Oncology", "Intermediate Filament Proteins", "Cancer Chemotherapy, Current Status" and "Immunotherapy of Cancer Metastases", all being contributed by Senior Members of the Staff of DKFZ, including one on "Administration of Scientific Research". The cover was a colour image of a three-dimensional structure of a transfer RNA molecule. I was told that the issue remained a success for several years.

Lord Ashby FRS, a Member of the Editorial Board of ISR, responded to the suggestion made during the Editorial Board Dinner in July 1988 [Title 362], that Members of the Board should discuss the major problems confronting science before the end of the century. He chose the work of the House of Lords as it affected science and how science was used by Government, subjects rarely, if ever, brought to the notice of scientists in general.

A Select Committee on Science and Technology of the House of Lords was established in 1980. It is in continuous session, creates its own agenda and publishes all its reports. Once a topic of study has been selected, written and oral information is invited and heard in public, recommendations are finally drafted and a report presented to the House for debate. The Government may then issue a response, or adopt the recommendations in due course. All this is public and anyone can attend the Committee's deliberations.

The first report in 1981 dealt with the disposal of toxic waste at a site called the Pitsea Landfill, where conditions were particularly obnoxious. The local Council requested help from the Department of the Environment, but they were refused twice and at this stage the Committee of the House of Lords took up the complaints. Finally it produced a most authoritative summary on the science and technology of toxic-waste disposal. The report embarrassed the Government, a television program brought the appalling situation to the notice of the public, and the Select Committee was established "as a body to be respected and in (some quarters) to be feared" as Lord Ashby wrote.

What report after report by the Select Committee showed was that science was neglected, and hence advice by scientists to the Civil Service in various Government Departments, was practically non-existent. The knowledge of university scientists was left untapped and "the universities' abilities to participate in the government's problems is simply not being taken advantage of". The Committee concluded that "what above all is needed, is a strengthening of the scientific dimension in Government as a whole". When the Select Committee reviewed the position of science a few years later, they concluded "that the general state of science in government in the UK had not improved and in some areas it had even become worse."

The Committee has published reports on many subjects such as forestry, electric vehicles, the water industry, remote sensing and digital mapping, agricultural and environmental research, occupational health and hygiene services, science and technology in local government, marine science and technology, UK Space Policy, priorities in medical research and new surface transport.

ISR 15/1 *Excellent Interdisciplinary Issue (I)* Title 370

Looking through the 21 volumes of ISR which I edited between 1976 and 1996, and inspecting each of the 84 issues of about 100 pages, I was naturally struck that some issues were infinitely more interdisciplinary than others. Not only was each Comment or article more in accord with the philosophy of the Journal, but each Issue as a whole combined contributions from many different disciplines, on a micro- and a macro-scale, thus creating a picture of interdisciplinarity par excellence. Such an outstanding Issue was ISR Volume 15, Number 1.

How did this happen? I have always worked with one year's capital of 15 to 20 articles and comments in hand, so that on press-day I could select and produce the best possible issue for the next publication. This fortuitous selection occurred during the summer of 1989 but this chance event cannot be explained. It did lead however to the excellent ISR 15/1 in March 1990.

My own Editorial "When Peace breaks out" attacked once again the astronomical expenditure on armaments and suggested as an alternative to spend an equal amount on space exploration, of greater benefit to mankind. The statue of the *Caller for Peace* outside Berlin's Brandenburg Gate inspired me to write this ever relevant essay. The following Comment "Bridges" was written by Lisa Heinz, a member of the Washington Office of Technology Assessment, and she outlined the interdisciplinary advantages of the Internet, just then coming into more general use.

"Interdisciplinary Research Centers" by Emeritus Professor David Tabor of the Cavendish Laboratory in Cambridge stressed the advantages of the 17 Interdisciplinary Research Centers set up by the U K Science and Engineering Research Council, and described the one in Cambridge where he had worked.

An entirely different aspect of interdisciplinary work was illustrated by Professor Ed Creutz, a Member of the ISR Editorial Board and formerly Director of the Bernice Pauahi Bishop Museum in Honolulu, Hawaii. They had received ancient *tapa,* a bark cloth, and Creutz explained in his article "Interdisciplinary Research is needed" how the identification of the tree by a botanist, the colour of the dye by a chemist, the mineral pigment by a geologist and the cultural context by an anthropologist, all combined for the display.

Professor Carlo Rubbia, the Director General of CERN in Geneva, wrote about "The Universality of Science and International Co-operation" holding up WHO and CERN as examples of modern co-operation, whereas in the past science progressed mostly at universities, where kindred spirits could easily meet.

Sir Hermann Bondi, a Member of our Editorial Board and Master of Churchill College, Cambridge, wrote about "Ocean Sensing" and based it on his talk to the Hydrographic Society. Bondi reviewed optical and microwave sensors, and pointed out that the topography of the seas could now be accurately measured by satellite, thus giving the slope of the surface generated by Coriolis forces.

Dr Larkin Kerwin, another member of the Editorial Board and President of the National Research Council of Canada in Ottawa, pleaded in his brief article for a „Disaster Relief Brigade"for natural and man-made disasters. After giving some examples where ad hoc aid had come to the victims from military forces, Kerwin suggested that if one percent of the military resources of a nation were assigned to disaster relief, the cost would be negligible. From national relief operations these brigades could move forward to international help, a subject for which I had pleaded in two previous Editorials, in 1977 and 1984. Regrettably, these ideas have never been taken up and each new disaster leads again to much loss of life which could have been avoided by properly trained and equipped Disaster Relief Brigades. [See Title 81]

So far this excellent issue had contained seven short contributions and these were followed by another seven, major articles. The first dealt with "Biocompatibility: Performance in the Surgical Reconstruction of Man" by Professor D.F. Williams of the Institute of Bioengineering of the University of Liverpool. The subject is in the author's definition "interdisciplinary par excellence".

From the medical research laboratory to an article about a laboratory of nature, the "Makhtesh Ramon" in Israel's Negev Desert where for the last 40 years sporadic and unrelated research field work had been carried out. Now an interdisciplinary master plan had been worked out by Professor Emanuel Mazor of the Weizmann Institute in Rehovot. The report is illustrated by 21 excellent photographs.

"The Migration of Physical Scientists to Molecular Biology and its Impact" is the title of Dr S.B. Dev' s contribution, coming from the Department of Applied Biological Sciences of MIT, Cambridge Ma. For this research, the author interviewed Linus Pauling, Salvador Luria, Seymour Benzer, Howard Berg, John Hopfield, Edward Purcell, Walter Gilbert and Ivar Giaever. He concluded that the great outstanding problems of molecular biology, for example the origin of life, are of an interdisciplinary physical and chemical, and not of a purely biological, nature.

The scientific and technological changes which have led to a surplus in agricultural products have not been of equal benefit to all consumers, as international trade barriers have remained unchanged. "Toward a Global Agricultural System" is the plea of Professor Vernon W. Ruttan and Harald von Witzke of the Department of Agricultural Economics at the University of Minnesota. They argue that it is in the interest of all, producers and consumers, in developed and developing countries, to move towards an international trading regime in which agricultural commodities move across national borders at least as freely as financial resources. I met Professor Ruttan during a visit to his University, was impressed by his logical solution and glad when he agreed to publish his arguments in ISR.

Yet another aspect of technology, the "Designing a Combat Aeroplane" demonstrated in this issue the interdisciplinary aspects which have to be mastered by the designer of modern military aircraft. I was fortunate in that I could persuade B.R.A. Burns of British Aerospace, Warton, Chief Aerodynamicist and Manager of HOTOL, to prepare his article before his untimely death. In it he showed that the conflict between different engineering disciplines can only be resolved by interdisciplinary co-operation among the designers, aerodynamicists, structural and systems engineers to produce a satisfactory compromise. He concluded that in future designs will be more strongly influenced by requirements for stealth.

How chance and constant curiosity can help an interdisciplinary Editor is shown by Dr Ursula Seibold's article on "Meteorology in Turner's Paintings". I met her at a birthday festivity of her father's, Professor Eugen Seibold, a Member of our Editorial Board, and learnt from her that she had in her art-historical career spent a year at the Courtauld Institute of Art in London. Our talk soon turned to her special interests in the history of colour in the 19th century and thus to the subject of her contribution to ISR. She characterised Turner's style 'to combine a given landscape with a meteorological scene observed elsewhere'. Nine of his greatest paintings were reproduced in the article from the Clore Gallery by permission of the Tate Gallery, but unfortunately the monochrome reproductions gave neither the scholarly author (48 references!) nor Turner, the full credit they deserved.

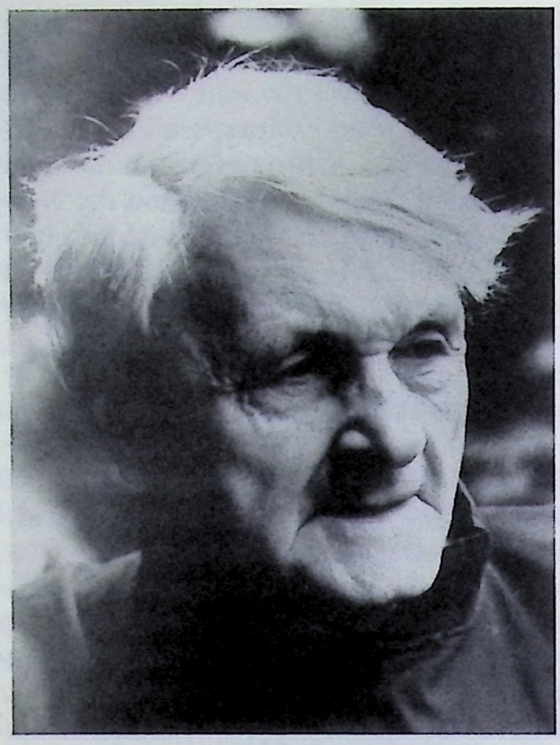
A remarkable 350-Year-Anniversary, the first publication of the action of quinine to reduce intermittent fevers, was the subject of the last article of this extraordinary interdisciplinary issue. Professor L.J. Bruce-Chwatt was the author, but because of his death, Professor Charles Engel, also of the Wellcome Tropical Institute, saw it through the press.

Here I can only repeat my solemn entreaty to produce a *'soma'*, an ideal drug, as no other solution to the drug problem appears to exists. In his Foreword, "Bridges between the two Cultures", to *Interdisciplinary Thoughts* Eric Ashby wrote: "One of the remarkable features of ISR are the brief and lucid Editorials, all written by Michaelis." My drug editorial grew from the usual one or two pages to more than seven pages, as I wrote about the historical use of drugs in the Old and the New World, about narcotics in literature, about stopping prohibition, and Aldous Huxley's mescaline experiments. The only scientific solution to the drug problem which I could offer was the 'Socially Sanctionable Drug', SSD, proposed by Matthew Huxley, the son of Aldous, in ISR Vol. 1, page 176 (1976), here Title 264. This 'ideal drug' would induce euphoria, be pleasantly hallucinogenic, gently alter the state of consciousness without leading to addiction, and fail to produce the other undesirable after-effects of present drugs.

The only aspect of my Drug Editorial of 1990 which has changed in 10 years, is the new traffic route to bring heroin from South East Asia into Western Europe after the War in Bosnia blocked the old Balkan Pipeline. Also South Africa has now become a new center of drug transshipment from South America. In all other aspects the drug problem has remained unchanged, no penalties, however severe, have deterred criminals from trafficking and from synthesising new more potent synthetic varieties. Remedies which have been tried, such as substituting other agricultural products, instead of growing cocoa leaves, opium poppies or Indian hemp, have failed, as the sale of the alternative crops proved financially quite inadequate for the peasant growers.

Manufactured by the pharmaceutical industry, the 'soma' would be released for public consumption under strictly controlled conditions, all specified by Matthew Huxley. It would create huge profits for the industry and high taxes for the State prepared to licence it. But none of the global pharmaceutical company has dared to add to its analgetic research any effort to produce a soma. Are these rich companies, spending world-wide several thousand million dollars on research each year, afraid of ethical opprobrium by the medical profession, or of terrorist attacks by the mafia, losing one of its most profitable trade? Or would the elimination of the life-shortening consequences of drug-addiction through the existence of a soma, not be of profit-making priority in the companies' conventional search for remedies against the traditional diseases?

Unless an enterprising pharmaceutical company produces a soma, the ever-worsening drug problem will continue to spread its world-wide misery for many more years to come.



Title 374

Dr Joseph Needham on his 90^{th} Birthday in 1990, received congratulations from a special Delegation of the Chinese Academy of Science who had travelled to England for this purpose to deliver them to him in Cambridge. *Courtesy Needham Research Institute.*

Joseph Needham was undoubtedly the most distinguished scientist and scholar I met in my life. When I took over as Editor of *Discovery* in 1956, Joseph Needham had just started his magnum opus, *Science and Civilisation in China*, the first volume of which appeared in 1954 and its breathtaking, all-science embracing outline made it famous even then. At the time of writing these notes, 1998, a total of 17 large volumes take up 86 cm on my shelves, and it is expected that the complete opus will extend to 30 volumes. In my opinion, rightly, it has been called "the greatest work of historical scholarship of the 20th century". I often met Needham, read his works, and esteemed him greatly.

Needham, born in 1900, joined the Editorial Board of ISR at the inception of the Journal in 1976, and it became customary later to celebrate a Board Member's 80th Birthday with a contribution of his own choice. This was not yet usual when the Journal was only four years old and when Needham was 80, but it was corrected 10 years later in the issue of ISR 15/4 after Needham had celebrated his 90th birthday on 9 December 1990.

"A Personal Impression" was contributed by his life-long friend W. Brian Harland and this was followed by "China and Europe—Their Different Progress in Science" a joint analysis by Needham and by Colin Ronan who was at the time the Secretary of the East Asian History of Science Trust and the author of *The Shorter Science and Civilisation of China* of which three volumes had appeared by then. The article attempted the almost impossible task of summarising 15 volumes in a few pages.

Harland gave an intimate and moving biographical sketch how Needham had been attracted to China, its culture and history, since his undergraduate days and how Needham's Christian social conscience had been easily confused by the ignorant with Marxist communism. Needham as Head of the British Scientific Mission at H.M. Embassy in Peking, had travelled throughout China during World War II, and had obtained an encyclopaedic knowledge of the whole of Chinese scientific activities.

What started as a single historical research broadened, and he called experts to help, and it blossomed into a Research Institute, now named after him. It is housed in a new beautiful building in Cambridge, in almost Chinese style, from which *Science and Civilisation in China* is guided and completed. I started at first to buy the volumes as they appeared, but later could not afford to continue this costly habit. I therefore reviewed for ISR each new volume as it came from the Cambridge University Press, an activity which made me admire Needham more and more, as his spirit continues, in spite of his death, to inspire us all. [See Appendix II, Bibliography, Title 428]

Title 375

'n 1991 the Institute of Metals, later the Institute of Materials, became the publisher *of Interdisciplinary 'cience Reviews.* Its offices are at Number 1 Carlton House Terrace, part of the famous Regency Terraces n the center of London. They were built by John Nash (1752–1835), architect and city planner, and work began in 1811. Number 1 is on the far right. ***Engraving published 1831, Author's Collection.***

J.W. Arrowsmith, the excellent printers of ISR in Bristol since the beginning in 1976, and publishers since 1983, decided early in 1990 that they could no longer bear the financial loss involved in its publication and therefore decided to put ISR up for public auction. Bids were to be submitted by 1 April 1990, but none materialised and I therefore acquired it myself. However, I soon realised that I could not publish a Journal from my flat in London and I bemoaned this at the Savile Club where Erasmus Darwin heard my complaints.

He simply said: "We shall gladly publish it for you, Anthony". At the time Erasmus, the direct descendent of Erasmus and Charles Darwin, was the Honorary Treasurer of the Institute of Metals which had for some time looked for a suitable Journal to expand its range of publications. The Institute of Metals was a learned Society with superb Nash premises at 1 Carlton House Terrace, and a world wide membership of 12500 members, tracing its history back to 1869. Later it changed its name to the Institute of Materials and has continued to publish ISR since 1991.

My first Editorial for the new volume and for the fourth publisher, was inspired by a United Nations Publication on the State of the World Population. It contained not only the relevant statistics on the human population explosion, but also for the first time on world-wide motor car production and expansion. I quote my conclusion: "As the exponential growth of cars is twice as fast as the well-known exponential increase of the human population, a breakdown of the car culture, as we have it today, can only be a few decades away."

In 1990, there were twice as many people as in 1950, but seven times as many cars. World car-production had reached 29700000 annually, but as the life expectancy of a car is only about 10 years, and only 10% of all cars are annually withdrawn from the roads, congestion will inevitably increase. The car industry is unlikely to abandon its lucrative business. Unfortunately I could offer no solutions to this problem. Rebuilding of cities, more motorways, vast expansion of public transport in the Western and the Third Worlds, electronic traffic control, must all be considered as palliatives, if at all possible in a democratic society. It convinced me that the outlook was indeed grim.

The only fundamental solution to the present human transport frustration I could propose was "Electronic Communicating instead of Commuting" with 'telework' by computer from home. This has natural limits, however ideal it may appear in an utopian world. If no radical changes are planned well in advance, the decaying car culture will not be replaced by its electronic sequel.

As I got to know the Members of the Editorial Board better and better and discovered their personal interests, I found that, Professor Nicholas Kurti of Oxford and Professor Heinz Maier-Leibnitz of Munich, were both eminent physicists and gourmet cooks, who had published cookery books under their own name. Maier-Leibnitz had even invented a method of combining cooking and chairmanship of a committee, which I have already fully mentioned on Title 291. His most advanced book, together with Traude Cless-Bernert, *Mikrowellen-Kochkurs für Füchse*, Piper 1989, introduced microwave cookery to German and Austrian recipes.

Maier-Leibnitz of course knew my own interest in good food, and on two occasions cooked a lunch for me. While he was chairman of the DFG, the German Research Association, an appointment which demanded all his attention, such meals were considered a great honour which a scientist could receive. For both menus he chose cooking in rock salt, once a chicken and once a small leg of lamb, both delicious. I had never heard of, nor tasted the results of this culinary technique which preserves all natural juices in the meat, or the fish, if such is the meal.

At another occasion, Maier-LLeibnitz was a speaker at a symposium in the humanistic world, entitled "The Culture of Eating". It was a rare event for a professor of physics and he told me of its interdisciplinary character.

What was even more important, he suggested a colleague who would be prepared to write it up for ISR. The three-day meeting took place in Selb, Bavaria, was sponsored by the Rosenthal Company, the manufacturers of fine porcelain, and was supported by the D.F.G. The report for ISR was written by Professor Dr Trude Ehlert from the Department of Germanistics, the University of Bonn. I do not know if the proceedings were ever published.

I realised how all-embracing the subject of 'eating' was considered, and I regretted that I had not been invited to report it. Nietzsche's philosophy of nutrition, the mportance of dinner parties in Kant's daily life, a cultural psychology of taste and the aesthetic pleasures of eating, were the opening themes. The vast literature of eating was next considered, including talking about eating, table manners, German culinary neologisms, and the ideal cookery book was defined by Maier-Leibnitz. After-dinner speaking was demonstrated in a talk about its history and function after a festive dinner, and finally the different cultural aspects of the subject of 'Tourism and Eating' were analysed. All speakers were eminent academics from German Universities, and it was finally agreed that only interdisciplinary studies of eating could act as a basis for future research in this important subject.

Many astronomer and other scientists, including myself, have criticised astrology for various reasons, but in the author's opinion, it is not their primary responsibility to tackle borderline subjects, as this is the task of a philosopher of science. Such is the qualification of Professor Dr Bernulf Kanitscheider of the Center for the Philosophy of Science of the Justus-Liebig University in Giessen, Germany.

I had read in *Universitas* (1989) a German article of his "Steht es in den Sternen?" and I asked him to republish it in English in ISR, to which he agreed and translated it himself. In his view, astrology must be seen in its origin as a religion based on the stars, which were considered as gods with a purposeful will to influence humans. Ptolemaios, author of *Tetrabiblos*, the virtual Bible of astrology to this day, realised that the physical mechanism whereby stars influenced men, would have to be elucidated, considering the influence of Sun and Moon on tides and weather as guidelines and models for astrological interactions.

During the Renaissance, fundamental difficulties arose as a consequence of the new heliocentric astronomy. Astrology is entrenched in geocentric thinking, whereas heliocentricity endows three motions, rotation, orbital revolution and precession, to our Planet Earth. The two systems diverge at the rate of one zodiacal sign approximately every 2000 years, and hence all astrological predictions of recent centuries would be wrong. "It is a strange assumption that the space where constellations were 2000 years ago is now saturated with a residual field of force, that is the source of their influence on our fates today" writes Kanitscheider.

Another modern physical discovery, the absolute speed of light, has presented difficulties to astrologers. Light from Uranus takes 2.5 hours to reach the Earth, and if on an astrological chart Uranus is shown high in the sky at a child's birth, it is actually in the descendant if one takes account of the delay due to the finite speed of light. This time delay affects all influences deriving from the stars as well as those from the planets. After reviewing attempts at statistical correlations between astrological forecasts and qualitative personal traits, the author warns the reader to be skeptical about claims of correlations, as those can easily arise through arbitrary classifications of professions.

However, in spite of all doubts, if astrology is only considered as a life support, perhaps as a substitute for religion, as a kind of practical wisdom, derived only in name through history from stars and planets, then the way might be open for a peaceful coexistence between astrology and astronomy.

Professor Amartya Sen, Nobel Laureate of the Department of Economics, Harvard University, experienced the horrors of the 1943 famine in Bengal as a 9-year-old boy , and argued in the Arturo-Tanco Memorial Lecture, reprinted in ISR in 1991, that systematic public action can eliminate the terrible problems of starvation and hunger in the present world.

He divides his subject into acute famine and endemic deprivation. No acute famines have occurred in India since Independence in 1947, and a number of threatened famines in 1973, 1979 and 1987 were prevented by rapid public action before they could become major killers. However, chronic under-nourishment and endemic deprivation are still prevalent in India, due to parasitic diseases and also partly lack of public health and absence of female education. Quoting the State of Kerala in south-west India, when life expectancy at birth is compared with other Indian States, Kerala has a remarkably longer expectancy of 70 years than the Indian average of about 57 years. Massive female education began as early as 1817, when Rani Gouri Parvathi Bai was the ruling female Monarch of the State of Travancore.

Other examples are Cuba and China, Hong Kong, Singapore and South Korea where massive investments in public health, epidemiological control and basic education have brought an equal prolongation of life. It is noteworthy to realise that poor countries can afford public health and education, because of low wages to nurses and teachers.

Quoting examples of famines in India and elsewhere, Sen maintains that these are due to loss of purchasing power entitlements by various groups of people in particular regions and thus lead to starvation. Different economic factors are responsible for this loss, and he recommends that public employment and the payment of cash wages is an efficient manner of counteraction, better than trying long-term increased food production or camp life with free food. Successful cases from India and Sub-Saharan Africa are quoted.

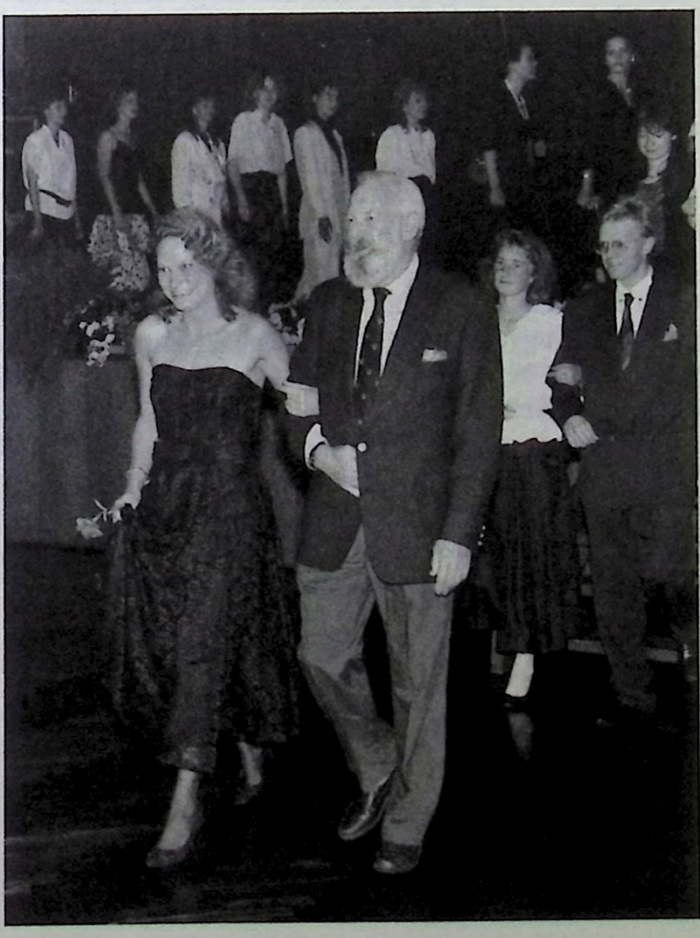
In Sen's opinion the real obstacles to efficient famine prevention and amelioration lie in undemocratic governments and a censorship of the media. Governments will take action when threatened with loss of power, and only in a free democracy can the news media and an efficient political opposition, compel Governments to take early and worthwhile counter-famine action. Ultimately the protest of the public is the most essential aspect of the whole process. The people must fully use the democratic process to force the government to take the right preventive measures and rid the country not only of spectacular famines, but also of endemic undernourishment.

Title 379

Dr Christian Anfinsen, Nobel Laureate, was until his death a Member of the ISR Editorial Board and a regular visitor from the Johns Hopkins University to the Lindau Meetings where I (left) always had long interdisciplinary talks with him. *Courtesy Kemmer, Lindau.*

Title 379

In addition to the serious lectures during the day in the Insel Halle in Lindau, festivities for Nobel Laureates and students take place there in the evenings. Here the **Author** leads an attractive, but unknown, young student in the **Polonaise** in 1989, the annual event which inaugurates the relaxed atmosphere of the Meeting. *Copyright photograph Dietlind Castor, Lindau.*



Alfred Nobel's generous Will, made in Paris in 1895, contained the operating phrase: "Prizes to those who have conferred the greatest benefit to mankind through their research in the preceding year in medicine, chemistry and physics". One of the quite unexpected consequences was that two medical men on the Island of Lindau in Lake Constance, Germany's greatest inland lake, decided in 1950 to organise regular annual Meetings of Nobel Laureates in their Home Town. Six years after the defeat of Germany in World War II, they argued correctly that such Meetings, if attended by foreign Laureates, would help to rebuild world-wide scientific contacts, lost during the War.

These Meetings, which I attended regularly since 1977, proved of great benefit to ISR, as I could persuade one of the Speakers each year to send me their texts for publication. Furthermore the personal contact and discussion with the world's greatest scientists was always informative and stimulating. It should never be forgotten that the award of a Nobel Prize, now for a century—the first was announced in 1901—is the highest distinction which any man or woman can achieve. Neither an Olympic Gold Medal nor a Hollywood Oscar is anywhere near it, as the Nobel Prize is only awarded for pure intellectual grandeur, far beyond physical prowess or artistic performance.

The Nobel Laureates are invited by the Lindau Curatorium, who take care of their travelling expenses and hotel accommodation as well as those of a large number, about 500, young scientists from German and European universities. Their attendance at the lectures is much appreciated, and the Laureates enjoy their talks with, and comments by, the next generation. The financial support for these Meetings comes from German Governments, both Federal and Länder, from industry and local sources. Whereas the names of the donors are noted on the program, the detailed figures need, according to German Law, only be divulged to Members of the Curatorium.

After the 1995 Lindau Meeting, Chemistry, I wrote a very critical Editorial which I published in ISR 20/3. The chemistry lectures had become pure physics and mathematical calculations and the greatest benefit to mankind could not even be guessed. I suggested that the Nobel Committee in awarding their prizes should emphasise the benefits to mankind in their announcement of the prizes, and the Lindau Curatorium should insist that speakers refer to these benefits in their lectures. Only Lord Porter FRS told the audience in 1995 how his own research subject, photosynthesis, might have a decisive influence on renewable sources of energy for the benefit of mankind. If these chemical benefits to mankind were more widely known and reported by the media present at Lindau, the adverse reputation of chemistry might be removed [see Titles 405-407].

After moving to the Augustinum in Heidelberg in July 1996, I was often asked what I missed most after my life in London. The answer was simple: "My Club" (See Title 335) where I regularly lunched one or twice a week and greatly enjoyed the companionship of fellow members. I had heard of Rotary International, and I knew that its Clubs existed in Germany, but I also knew that its membership was far more exclusive in Germany than in England. Of the 72 Members of the Heidelberg Rotary Club, 33 are professors, 25 have academic titles and 14 are senior businessmen.

Rotary International was founded in 1905 by a young lawyer, P. Harris in Chicago, to foster the 'ideal of service', to encourage high ethical standards as a basis of enterprise, and to promote world fellowship of business and professional men. His plan also restricted membership in each club to a single member of each business and profession.

Through the courtesy of Professor Peter Brix and later Professor Gisbert zu Putlitz, both of the University of Heidelberg, I was invited to come to the luncheons of the Rotary Club, meeting every Tuesday at the Europäischer Hof, the best hotel in town. I was even asked to address the club on my professional work, which I considered to be 'Science-Journalism'. After that I was given to understand that I should not come to further meetings, as my possible election had reached a critical stage because my age was over 80. I gave up all hope.

Then suddenly I was told that I had been elected an Honorary Member. I was officially informed by the Club's President, Joachim Plass on 9 June 1998, during a most interesting visit to the large Tannery Company of Carl Freudenberg in Weinheim. In his after-lunch speech Plass told the assembled Members that I deserved to be an honorary member because, in the period after World War II, I had contributed "in the Rotary Spirit", to renewed contacts between English and German scientists. It was the same citation which was quoted for my Verdienstkreuz.

The Freudenberg Tannery Works, dating back to 1849, used a combination of modern technology and traditional craftsmanship to produce calf leather of the highest quality for top European firms, like Hermes, Gucci and Ferragamo as well as John Lobb's shoe-shop, in London. Where possible, automation for the chromium tanning process was introduced, as a daily throughput of about 1000 hides demanded. Yet constant quality control by highly skilled tanners and other craftsmen succeeded in making one of the oldest human manual crafts produce into modern, uniformly excellent, rawhite.

ISR 17/1 *Stock Exchange Electronic Information* Title 381

Dr Vary T. Coates, the author of this article, was at the time a Project Director at the Office of Technology Assessment, US Congress, in Washington DC, and among her tasks had been an assessment of the impact of electronic information technology on the world's stock exchanges. In her first contribution in 1991 on this subject [ISR 16/3], she considered "Securities Markets—Global and Perpetual." In that review she emphasised the internationalisation of securities trading around the clock, overcoming the different time zones. It was in early 1998 that the Asian Financial Crisis, spreading rapidly from country to country, proved her assessment of 1991 to be a very accurate one.

By the time her second article appeared in 1992, Vary, the wife of Joseph Coates, a Member of the Editorial Board of ISR, had become a good friend and I had learnt to appreciate her great gifts of communication. I reviewed all articles I published in ISR and selected a few for inclusion in this book, and her contribution about "US Stock Exchanges" deserves the title *La crème de la crème.* Its subject was the old and well-known conflict between modern technology replacing human performance sanctioned by tradition and hence bitterly resented, particularly so in this case, because the human practitioners lost great financial benefits.

The scene of the conflict described by Vary Coates is principally the New York Stock Exchange with its complex variety of actors and its explosive growth in recent times, which the human practitioners could no longer master after the late 1960s. The human agents, the 'specialists', endeavoured to follow their 100 year-old tradition with a variety of computer-aids, like NASDAQ, to transact the blocks of a million shares offered and bought by large institutional investors, for example pension plans, mutual funds and insurance companies.

On 19 October 1987, more than 600 million shares were to be traded, but the orders could not be executed by the specialists because of lack of capital and a Crash resulted. Five future alternatives were outlined in the article, all based on better and bigger electronic information exchanges, aided by international telecommunication networks.

This brilliant interdisciplinary contribution about the impact of the Scientific Temper was clearly understandable by non-financial experts, and the brief summary here should encourage the reading of the original articles in ISR, or better still the two full Office of Technology Assessment, OTA, Reports published by the US Government Printing Office in July and September 1990.

ISR 17/2 *Earth Summit—Lasting Development* Title 382

This issue of the Journal was almost entirely devoted to the United Nations Conference on Environment and Development, UNCED, in Rio de Janeiro 1992, usually called 'The Earth Summit'. Like its predecessor in Stockholm in 1972 [Title 233], it attracted heads of state and diplomats, scientists and civil servants, fringe ecologists and UN officials, all endeavouring to solve—according to their own prescriptions—the grave problems facing Planet Earth. Years of preparatory work and $ 30 million had been invested, and not surprisingly a very great deal of advance publicity had been generated in the media world-wide. I decided to collect suitable contributions for this Special Issue, to be published at the opening of the Conference, 3 June 1992.

Maurice Strong, by birth a Canadian, was Secretary General of both the Stockholm and Rio Conferences, and in his contribution to the Issue described the results of Stockholm, as well as the subsequent Brundtland Commission and its 1987 Report *Our Common Future.* He outlined the aims of Rio, to establish a new basis for the relations between rich and poor, between the North and the South, and declared that a concerted attack on poverty was the central priority for the 21st century. "This was imperative for our environmental security, on moral and humanitarian grounds, and the least we can do for future generations, from whom we had borrowed a fragile Planet, called Earth" Strong wrote.

Among the other contributors were:
The Royal Society and the National Academy of Sciences: Population Growth,Resource Consumption and a Sustainable World
Janet R. Caristo-Verrill: A Civilian-Military Conservation Corps
Farouk el-Baz: Kuwait's Oil Lakes—A new Phenomenon
Lord Dainton FRS: Knowledge is our Destiny
H. Güttinger and W. Stumm: Ecotoxicology: The Rhine Pollution caused by the Sandoz Chemical Accident, 1986
T.F. Malone: Global Change—The Human and International Dimension of Science—View of the Possible
Stephen H. Schneider: Global Climate Change—Ecosystem Effects
Vary T. Coates: Human Rights and Scientific and Technological Development
Jacques Richardson: The Military Factor in Scientific Research
H. Maier-Leibnitz: Science and the Humanities—A Plea for Interdisciplinary Communications
Deborah Lucas: Understanding the human Factors in Disasters.

Alas, it was only a small contribution to Sustainable Development.

If the contents of the preceding ISR Issue on "The Earth Summit", 17/2, was entirely chosen by me, then the two subsequent Issues, 17/3 and 17/4, were sponsored by the World Gold Council, and a number of the 24 articles were suggested by the sponsor. Provided they were up to the Journal's high standard, I was glad to accept them for publication. The title of the first Issue was *Gold: Art, Science and Technology* and as there was a large surplus of articles, a second Issue was called *Focus on Gold*. Several thousand copies of each were printed, and I was informed by the sponsor that they were very satisfied with appearance, production and contents of the two 'Gold' Issues.

As usual for a sponsored Special Issue, the covers were black, instead of the normal white, and a colour picture was reproduced both on the front and back covers. Great care was essential to choose subjects which, at the same time, proclaimed the unique qualities of gold and also represented art, science and technology. The front cover of 17/3 was an outstanding example of the caster's technological art, a common thistle cast in solid gold, 125 mm high, produced by the investment casting technique in such ultra-fine detail that the thistle's hairs could hardly be resolved by the naked eye. Production details were fully described in an article by Chris Walton of the Design and Technology Department of the Worshipful Company of Goldsmiths, who had crafted the Golden Thistle.

The back cover of 17/3 showed in the center the gold medal awarded to each Nobel Laureate, with the portrait of Alfred Nobel, 65 mm in diameter. It was placed on a circular background of a gold-plated microwave antenna, composed of a double spiral, each 1.90 m in length, although its actual diameter was only 50 mm. This composite picture gave a perfect frame to the greatest award for a scientist and symbolised the value of gold for one of its most sophisticated uses, described in an article by Dr David Jacobson.

On the front cover of 17/4, I was glad to reproduce an early Anglo-Saxon gold pendant with garnet and filigree decorations, 38 mm in diameter, from Faversham, Kent. It featured in Dr Justine Bayley's article originating from the Ancient Monument Laboratory of English Heritage, on "Goldworking in Britain—From Iron Age to Medieval Times". The back cover was blank.

As Editor of these two sponsored Issues, I was pleaser that I could not only assemble a great variety of articles by outstanding contributors, but could also present their contributions in the appropriate manner, worthy of the subject Gold. My Editorial, of six pages, the longest I ever wrote and the articles in these two issues are listed on the next Titles [384 and 385].

Gold is uniquely interdisciplinary among the 92 chemical elements. It is the oldest metal used by man, and its many beautiful works of art have survived millennia in an uncorroded state. It has therefore attracted the greed of man and woman, and innumerable wars and crimes have been committed in its name. I could only find Virgil's phrase from the *Aeneid* to express it all succinctly. It can be translated either as 'the unholy hunger' or the 'the sacred yearning' for gold, as *sacra* has these two meanings. Famen became 'famine'.

The subject is a vast one, and my Editorial began historically with the metal's antiquity and the 'Lesson of King Midas' whose greed should have been a warning. 'Gold rushes and gold museums' followed and then I wrote a paragraph about the 'adjective' gold, representing the best, the most glamorous, from the Golden Calf to the Gold Credit Card. 'Gold in the Bible' and Newton and Boyle's desire for gold were subsequent mini-essays not forgetting Fritz Haber's more recent alchemical dream to extract gold riches from sea water to pay for Germany's Versailles reparations.

I was amazed about the strange facts, fables and fantasies about gold which I discovered during my lengthy research reading. Toulouse-Lautrec dusted gold powder on an 1893 lithograph of Miss Loie Fuller to imply the shifting light on the dancer. Similar gold dust is an ingredient of 'Danziger Goldwasser', proclaimed as a potent digestive. Tiny particles of gold were said to have been ejected from Mount Erebus, the Antarctic Volcano, and some placer gold, when viewed under the scanning electron microscope, was found to resemble the structure of the common bacterium *Pedomicrobium*.

More fantastic is the fable of Megasthenes, who tells of the gold digging ants, now interpreted as Tibetan miners. But of all gold fantasies, El Dorado is the most famous. It originated in Columbus' missions for 'gospel and gold' and it received notoriety in Milton's *Paradise Lost* (1657) and Voltaire's *Candide* (written in 1758). Many serious explorers, including Sir Walter Raleigh, searched for it in 1595, far and wide. Their voyages opened up much of the unknown areas of the Americas. A gold-clad skeleton of a pre-Inca nobleman was reported in 1991 and thus finished my tale of El Dorado (Spanish for the 'Gilded One').

I concluded the Editorial by paying tribute to two famous mining engineers: Agricola, the author of *De re metallica* first published in 1556, and its translator, Herbert Hoover, (31st President of the USA). He and his scholarly wife made the first book ever devoted to any technology, mining, generally available. It included of course gold mining, and I reproduced a 16th century illustration of it in my text.

It is impossible here to do more than list the names of authors and the titles of their 'Gold' Articles which were published in the September and December Issues of ISR in 1992.

*ISR 17/3 *GOLD: ART, SCIENCE AND TECHNOLOGY **

P. Taimsalu	25 Years of *Gold Bulletin*
W.H. Prescott	The Inca's Ransom
W.S. Rapson	Mining, Extraction and Refining of Gold
H. Schmidhuber	Gold Chemistry is Different
R.V. Parish	Gold in Medicine—Chrysotherapy
P.J.N. Sinclair	The Economics of Gold
R. Murphy	The Monetary Role of Gold
C. Bocking, I.R. Christie	Gold Electroplating—Brief Overview
D.M. Jacobson	Gold in the Electronics Industry—Some new Developments in Semiconductor Packaging
B. Kempf, J. Hausselt	Gold, its Alloys and their Uses in Dentistry
J. Ogden	Gold in Antiquity
E. Drost, J. Hausselt	Uses of Gold in Jewellery
Chris Walton	Jewellery Production
G. Robinson	The Design of Gold Jewellery—Stimulation, Promotion by the World Gold Council

*ISR 17/4 *FOCUS ON GOLD**

Adrian Berry	Gold in Literature
A.R. Michaelis	The Golden Honeycomb by Michael Ayrton
Justine Bayley	Goldworking in Britain—Iron Age to Medieval
J. Nix	The Modern Goldsmith
D.M. Jacobson	Transmutation into Gold—a Solution to the Mystery
K. Clancy	Gold Coins and Medals
D.W. Evans	Assaying and Hallmarking
B.C. Middleton	The Gold Tooling of Books
F.R. Maddison	The Barber's Astrolabe
T. Tran	The Hydrometallurgy of Gold Processing
A.E. Torma	Bioenhanced Gold Extraction from Ores
M. Grimwade	The Metallurgy of Gold

I met the author of this iconoclastic book, Dr Christoph-Friedrich von Braun, through Frank Davidson, a Member of our Editorial Board. My first inquisitive comment to him was: "Are you by any chance a relative of Wernher von Braun?" and when he replied in the affirmative, I was immediately full of expectation to receive from him unusual and ingenious contributions to my Journal. I was not to be disappointed.

As I got to know Christoph, I learnt that he had received his doctorate from the University of Freiburg in the subject of space law, perhaps with the idea of following his famous uncle into space—I never asked. I also heard that he had a further degree in Technology Management from the Massachusetts Institute of Technology and wondered how his two qualifications had been used by him to the best advantage. He told me that he had worked in the electronic industry for Siemens, for 12 years and that he had lived in the USA, UK, Japan and Germany. When I met him in the early 1990s, he had spent an additional four years as a consultant in the engineering industry, a profession he enjoyed and continued in Munich.

He is a Member of the American Institute of Aeronautics and Astronautics, the World Future Society, the Japanese-German Society and of "1787 Berlin". His consultancy practice specialises in technology planning and organisational management. In 1994 he published his first book *Der Innovations-Krieg* which he himself translated into English as *The Innovation War,* and Prentice Hall published in the USA 1996. He kindly presented me with an inscribed copy of each. A brief review of the German edition appeared in ISR, 20 (1), p. 82, 1995 which, as Editor, I considered not adequate. I therefore reviewed in ISR 25 (1) p. 156, 2000 the subsequent American Edition myself.

In my critique, written in March 1993 I wrote: "This deep analysis of the innovation process is iconoclastic. Instead of pleading for more and more money for industrial research, the author concludes that spending on R&D growth has become excessive and, in the case of major industrial enterprises, needs a thorough review". In fact the author's thesis is: "Newer does not mean Smarter, Faster is not Better and Innovation does not mean Progress." He compared Innovation with the Cold War, when the USA and the USSR competed for more and more powerful weapons, until one of them lost this race, this Innovation War. This is not possible in an industrial competition as unlimited finance is simply not available. Keeping up with the competition, in Industry led to an 'industrial overkill' with, for example, bicycles having 36 gears. I recommended the book highly to all executives in Industry, as it was easy to read, almost in conversational style.

I had long discussions with Christoph von Braun about the subject of the contribution to ISR which he had promised, and somewhat hesitantly he asked if he could expand a short article he had written for *Die Zeit,* published on 26 October 1990 which he had called "*Das Mass aller Dinge*". I was glad to accept his suggestion, as it was highly interdisciplinary and very imaginative.

In his abstract for the article, published in March 1993, which he called "Numbers—Magic and Mania" he wrote: "Quantitative information has become the prime tool for the description of the world at large. Irrespective of a country's ideological disposition or level of development, statistics and numbers serve as ultimate sources of proof and disproof in all areas of science, technology, industry, society and everyday life. They are the dominant foundation of credibility and act as the prime channel of communication at the expense of verbal expression. The increasing use of numbers can be traced to classical Greece and has evolved ever since."

"In today's world this is threatening to lead to a quantitative overload. Although the human brain is not adept at performing complex calculations, or even the understanding of the significance of very large, very small or very many values simultaneously, society has become obsessed with numbers. At the same time growing technological sophistication in electronics, as well as analytical and measurement instrumentation allows—and therefore demands—levels of detail that far exceed the degree of precision actually required in many instances. This has led to counterproductive forms of number usage which serve more to confuse, than to clarify, or which hide more than they reveal."

"At the same time, forefront indicators in mathematics and natural science are pointing away from numerical thinking. Finally, the way in which the unbridled attempt to quantify ourselves and our world can lead to serious misinterpretations of reality, is illustrated. Ultimately, numbers are instruments of explanation, not of understanding. They should, therefore, be servants, not masters." What Editor would refuse such an article?

There were three illustrations to this article: The letter π as a symbol of a transcendental, timeless and endless number, portrayed in 25 concentric circles of ever increasing decimal places.The next illustration was a page of the *Wall Street Journal,* giving future prices. I could contribute a historical item from my own collection, a page from the inventor of logarithms, John Napier's (1550-1617). His first Continental Edition of *Mirifici logarithmorum canonis descriptio,* was published in Lyons, France, in 1619. Such logarithmic tables were of course indispensable for all scientific calculations, until the recent invention of the electronic calculators.

ISR 18/2 *Unmet Demand for Family Planning* Title 388

The need for family planning had been urged on many pages of ISR, as the world population increased and had continued unabated. By 12 October 1999 it had reached six thousand million. This figure demonstrated to me more clearly than any other statistics that during my own lifetime, from 1916 when I was born and world population numbered two thousand million, it had tripled! I was fortunate enough to find the expert who could write authoritatively about the whole of this interdisciplinary subject.

This was Malcolm Potts who is not only the President of International Family Health, London, but is also the Bixby–endowed Professor of Population Studies in the Department of Health Sciences at the University of California, in Berkeley. He is internationally recognised as one of the few true pioneers of family planning, in which he specialised during the last 25 years, as the author of 12 books and over 200 articles.

In his contribution to ISR, called "Unmet Demand for Family Planning", he dealt with 'The Biology of Reproduction', 'Family Planning Programmes: Policies and Management', 'Costs', 'Interrelationships', 'The Demographic Trap', 'AIDS', 'Population and Ecology' and 'Issues'. As Editor I was delighted that I had finally presented to my readers a thoroughly interdisciplinary article from the best author. It was published in June 1993.

Potts concluded that during the last decades, much had been learnt about family planning but that demographic problems had worsened and an annual growth rate of 1.8 % existed. As a result, by the year 2000 there would be one third more women of fertile age than in 1990 he wrote, because of the population explosion in the 1960s and 1970s. Wherever the right family planning had been available, fertility had begun to fall, but only when it met the needs of the individual and it did not violate the dignity and equality of the woman.

Currently the world is attempting to provide contraceptive services on a shoestring, Potts continued. Of the relatively small amount of money spent on international development by rich countries, less than one percent goes to family planning. As long as this remains the policy, the growth of global populations will stabilise at a higher level than zero. Population growth rates will only decline more rapidly if family planning is universally available [see Title 390]. This is not the only problem in the world, but it deserves more than one percent of the development equation, Potts demanded.

Family planning is built around proven technologies, where well defined inputs produce predictable changes. Fertility decline is no longer a problem looking for a solution, it is a problem looking for resources, Potts concluded.

This was a sponsored issue for the Karlsruhe Nuclear Research Center, better known perhaps as the *Kernforschungszentrum Karlsruhe.* Its change of policy and function, from only nuclear research to more general interdisciplinary subjects, was typical of the world with its wide decline of interest in atomic energy. Similar changes had occurred in England at the Harwell Research Center and also at the Lawrence Livermore Laboratory of the University of California.

I had an introduction to the Director of the Karlsruhe Center, Dr M. Popp, and we agreed that after general introductions by him and by me, there would be sections on the environment, on energy, on microsystem technology and basic research. I followed the, by now well established, practice of letting the sponsor suggest the detailed subjects of the contributions and their authors, while I retained the final decision, ensuring that the articles reached the usual academic level of ISR.

My Editorial which I entitled "Interdisciplinary Big Science" gave me a chance to refer to the history of 'Big Science' as first defined by Derek de Solla Price in 1963 in his book *Little Science, big Science* in which he also plotted the exponential growth curve of science. He defined 'Big Science' as a discipline which doubled every 15 years, measured predominantly by Price through the growth of the relevant scientific literature. I drew attention in my Editorial to the recent contraction of some fields of science, as for example atomic science, manned space flight, and supercomputers which were often replaced by numerous smaller ones of equivalent total power.

Dr Popp in his Introduction laid down the new tasks for Big Science, the sustained development for interdisciplinary technologies of which the articles in the issue were the examples, especially for non-polluting high technologies. For me, and I assumed for many of my readers, the most interesting and novel subjects in the special issue published in September 1993, dealt with microsystems on the nano scale.

Using the techniques of microelectronics, such as deep X-ray lithography, the research scientists at Karlsruhe produced microturbines with a diameter of only 100 micro meters. (1 micro meter is 10 to the power of minus 6) rotating at 150000 revolutions per minute and electric micromotors of only 0.25mm diameter as well as microsensors. So far the most important developments in this field are microspectrometers, chemical microsensors and microanalysers. Already well known and often used is the new technique of 'Minimally Invasive Surgery' which depends on a stereo-video-endoscope of minute size, which can be inserted through a very small incision into the human body, as for example for gall bladder removal.

ISR 18/4 *Science Summit on World Population* Title 390

Professor Potts's plea for Family Planning [see Title 388] was scheduled by me to precede the *Population Summit of the World's Scientific Academies* which took place in New Delhi in October 1993. It was attended by 58 Academies from all parts of the world. The Summit grew out of two previous meetings, one a joint meeting of the US Academy of Science with the Royal Society of London, and secondly an international conference organised by the Swedish Academy of Science. Both these meetings expressed an urgent concern about the expansion of the world's population and, if predictions were to prove accurate, science and technology might not be able to prevent irreversible degradation of the environment and continued poverty for much of the world.

The Summit was divided into five sessions:

The Complex Reality
Linkages between Population, natural Resources and the Environment
Demographic Transition in a Gender Perspective
Family Planning and Reproductive Health
The Future

and was followed by an International Press Conference. On all the publications of the Summit and on its notepaper, Henry Moore's "Family Group" was used as the logo for the Summit.

A joint statement was signed by all participating Academies and given widest possible publicity in the hope that governments and private decision-makers will implement the solutions suggested. I was able to obtain an early copy of the Statement and reproduced it in full in ISR 18/4 in December 1993. It was formally published in January 1994 when I, together with all other members of the English Scientific Press, received a letter from the President of the Royal Society, Sir Michael Atiyah OM, stating: "Your support is sought in ensuring that appropriate action is taken now to safeguard the future of our children and children's children".

The Statement urged among other tasks:

Achieving a zero population growth within the lifetime of our children
Equal opportunities for women and men, to make individual choices
Universal access to family planning
Elimination of unsafe and coercive practices
Clean water, sanitation, primary health care and education for all
A new ethic that eschews wasteful consumption
The industrialised world to assist the developing world to combat problems
Collective action by all countries.

ISR 19/1 *The Plutonium Legacy* Title 391

When America and Russia began to dismantle many of their nuclear weapons under various disarmament agreements, it became urgent to consider the future of plutonium. I was fortunate enough to find a highly qualified author, Frank Barnaby, who could write about this topic, and in my opinion a most important subject. His contribution was published in March 1994. The amount of military plutonium removed from weapons, and—almost casually—stored under civilian control in various countries, was by then rapidly increasing. The question of secure storage was pressing from a military, political, prevention of proliferation and social point of view.

The main problem with plutonium is that it is an extremely efficient explosive. Furthermore, from spent fuel elements in civilian reactors, increasing amounts of plutonium were chemically separated in commercial reprocessing plants and of course had to be stored. At present there are no economically viable and peaceful uses for plutonium, at least not until breeder reactors can be demonstrated to be commercially profitable. Because the theft of plutonium could have serious global consequences, Barnaby urged strict international management, rather than the current system of national ownership and control.

Frank Barnaby who had become a good friend, was by training a nuclear physicist who had worked for six years at the Atomic Weapons Research Establishment at Aldermaston in England and afterwards as the Executive Secretary of the Pugwash Conference on Science and World Affairs.

He became well-known as the Director (1971-1981) of the Stockholm Peace Research Institute which issued annual reports of world-wide military expenditure, of international interest, quoted in all good newspapers.

He illustrated his article, published in March 1994, with photographs of a plutonium blender and finishing line, as well as the actual storage cabinets of British Nuclear Fuels plc, all at Sellafield. Another illustration showed the equipment for plutonium isotope analysis at the German GSF Research Center at Neuherberg. I had never seen these photographs and doubted if they had been published before.

In his thorough treatment of the subject, Barnaby calculated the cost of the preferred plutonium oxide storage at $ 42 million annually, assuming a total of 300 t of plutonium by the year 2000. As plutonium is most vulnerable to theft and hijacking during transportation, he suggested actual storage sites in France, Britain, Russia, Japan and USA near commercial processing centers, but all under an International Regime. In view of the International Atomic Energy Agency's failure in Iraq, a new Agency, directly responsible to the Security Council of the United Nations, would be best, he concluded.

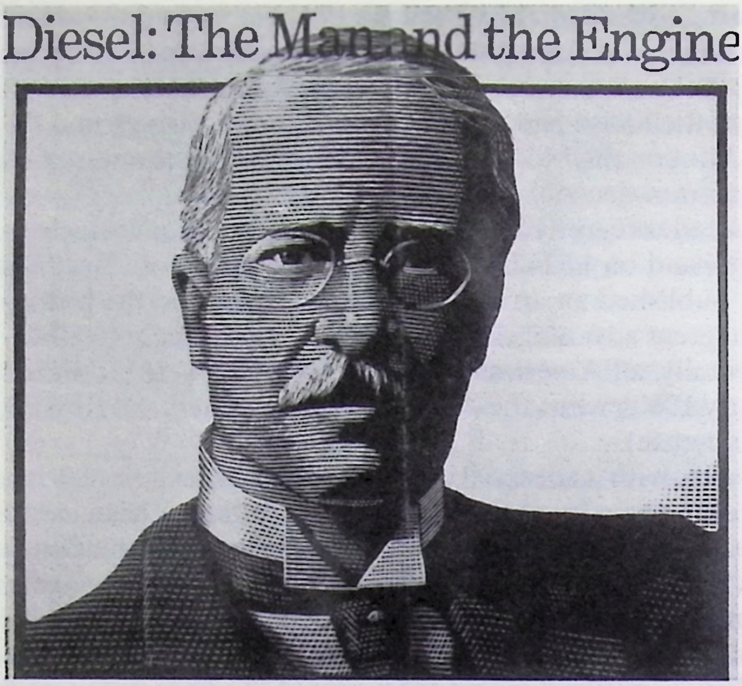
It was just 201 years ago—my ISR Editorial 19/2 of June 1994 had missed the actual bicentennial by one year—when the French National Convention in 1793 introduced the Metric System with the wish: *A TOUS LES TEMPS—A TOUS LES PEUPLES.* Two centuries later, their wish had almost come true, only Britain and the USA had, on Planet Earth, (not on the Moon!) remained faithful to the antiquated Imperial Measures with their non-decimal sub-divisions.

As a scientist, I had for decades regretted this fact, which was such an obstacle to truly international exchange, and on 11 February 1971, four days before Britain's coinage became decimal, I published an article in the *New Scientist* on the history of the decimal point and the great advantages this simple dot had brought to all scientific endeavours. (Incidentally, all American Maps of the Moon were published in metric notation in the early 1960s, when the Apollo Program started. All Russian Moon maps were of course metric).

The use of the metric system, with its decimal subdivisions, has a long history beginning with the invention of the zero by an unknown Indian mathematician in 595 AD. This notation travelled to the West through Arabian scholars, and the Dutch engineer Simon Stevenius (1548-1620) was the first to use it extensively for weights, measures and coinage. John Napier (1550-1617), who invented logarithms, also employed the decimal separatrix in the beginning of the 17th century, but it was not until 1793 that the Commission on Weights and Measures of the French National Convention officially legalised it.

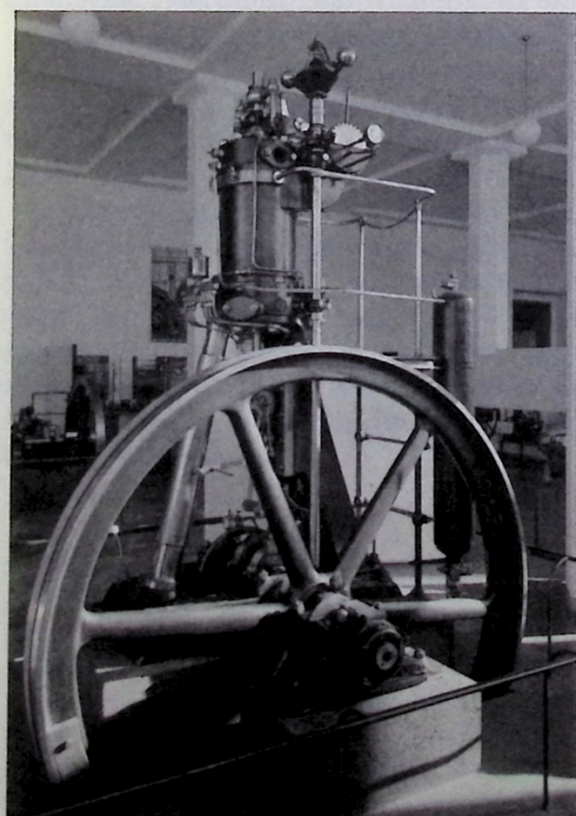
Had the British Government of 1790 accepted the French Government's invitation, jointly to prepare the universal standard for the meter—the ten-millionth part of the Meridian quadrant—and also for the kilogram, Britain would have been metric long ago and America would have followed immediately. But even in France, progress was slow. After 1799 Napoleon allowed both systems to be used side by side, creating universal confusion, until in 1840 the superiority of the metric system was generally accepted in France. Other European Countries, with the exception of Britain, followed in due course.

In the 1990s Britain had reached what one may call the half-way stage, with petrol being sold by the liter, but the price of crude petroleum still was quoted in barrels, following American practice. Progressive stores, like Marks and Spencer, had almost completed their metrication with 100 % textile merchandise, and food items 95 %. In America temperature is still, and now uniquely, measured in Fahrenheit. In 1994 the US General Accounting Office issued a report on *Metric Conversion*, found little progress in Industry and concluded that only public support would ever change this.



Title 393

Rudolf Diesel (1858–1913), in my opinion one of Germany's greatest engineers, whose engine has demonstrated the Scientific Temper all over the world, particularly for the benefit of greater food production. As a man, he is hardly remembered, but his name has become the designation for the fuel of his engines in all languages – and that is his best memorial. *Unknown source, Author's Collection.*



Title 393

The first **Diesel engine** was built 1896–1897 at MAN, Augsburg. This historical engineering achievement is now beautifully preserved in the Deutsche Museum, Munich. Its single cylinder has a diameter of 250 mm, its piston travels 400 mm and the engine delivers 20 HP at 172 revolutions per minute. *Courtesy Deutsche Museum, Munich.*

INTERDISCIPLINARY SCIENCE REVIEWS

A publication of The Institute of Materials

ISSN 0308–0188

Volume 19 Number 3 September 1994

Title 393–1994

The Diesel Centenary commemorated.

100 Years Diesel Engine — Economic and Social Impact

If in my March 1994 Editorial I was one year late to commemorate the origin of the Metric System, perhaps I recalled in my September Editorial the birth of the Diesel Engine two years early. The German engineer Rudolf Diesel (1858-1913) was granted his basic patent for a self-ignition oil engine in 1892, and already two years later, the 'Diesel Engine' was mentioned in the *Oxford English Dictionary* and also in *Webster's Collegiate Dictionary* of 1894. So perhaps the choice of my date to write about the world-wide impact of his invention, was not too wrong.

Today, with his original patent expired long ago, there are countless millions of Diesel Engines contributing to mankind's welfare and survival, ranging from driving a water pump in the desert to an emergency electricity generator in a hospital. Their power output covers the range from a fraction of a horsepower in the engine of a model aircraft, to tens of thousands for a giant ship propulsion Diesel engine. The relatively little-refined petroleum fraction, the preferred chemical energy source for Diesel engines, its fuel, has become the household word *Diesel*, untranslated in all languages.

One might therefore suppose that Rudolf Diesel would have received world-wide acclaim through memorials dedicated to him, especially in the third World, which has benefited most. But not so! The polluting exhaust fumes from neglected or badly adjusted engines in bus, truck and taxi, have prejudiced the name of Diesel, and the only anniversary commemoration I know, is a German DM 10 silver coin, struck in a small edition in 1996.

Modern agriculture, where the Diesel engine has replaced the horse, would today be unthinkable without it, be it for all tractors, harvesting machines and electricity generators for additional services on land and field. For the exponential growth of the world population, only the most efficient food production can improve our future outlook, grim enough as it is today.

Remote human activities, like the dozen research stations on the Antarctic, the astronomical observatories on distant mountains, oil production platforms in the North Sea, the isolated sheep stations in the Australian outback, or whenever satellite emergency communications become essential after a natural disaster, large and small, Diesel-driven electricity generators have proved their vital necessity for scientific research, for human welfare and survival.

The future of the Diesel engine will depend on the availability of its fuel, even if this has to be produced by the hydrogenation of coal by the Lurgi Process. But there is one place where no Diesel engine will ever help man—on the Moon.

Diesel provided an excellent example of the Scientific Temper.

... war has been completely spoilt. It is all the fault of Democracy and Science.
WINSTON S. CHURCHILL, 1930

I quoted this in my Editorial in December 1994, as I hoped a non-lethal peacegas would inhibit all terrorist activities, which had become so frequent during the last decades of the 20th century. If such a gas existed, with the properties of a powerful anaesthetic, it would allow the reversible immobilisation of an enemy, civil or foreign, for a short period and permit the removal of his weaponry. It would have been an ideal agent during the conflicts in Serbia, Bosnia and East Timor.

A peacegas would be more effective than a water cannon, less dangerous than rubber bullets or tear gas, it could be used from a small hand spray against a single antagonist or dispersed from a helicopter against large crowds. Is this another idea from science fiction, or just one of the ultra secret, non-lethal weapons at present being investigated by the Pentagon? [See: S.Aftergood "The soft-kill fallacy" *Bull. Atomic Sci.* 1994, 50 (5), p. 40] In his article, the author gave a 'laundry list', itemising infra-sound, laser weapons, supercaustics, biological agents, acoustic beam weapons, combustion inhibitors, and mini-nuclear weapons, all apparently being researched—but not peacegas.

The idea of a peacegas is by no means new and was first suggested by H.G. Wells in his book *The Shape of Things to come,* published in 1933. He described the collapse of world economy, widespread destruction and universal poverty, followed by encouraging signs of a revival. Wells wrote: "This was organised by the 'Air Police'. It had been equipped with a new type of gas bomb, releasing a gas called *Pacifin*, which rendered the victim insensible for about thirty-six hours and was said to have no further detrimental effect."

Might this be the third accurate forecast by H.G. Wells? In 1903, in his short story *The Land Ironclads* he forecast modern tank warfare. In his book *The World set free* he correctly anticipated in 1914 an 'atom bomb' —an expression he then coined—and the many terrible consequences of its use. So far, apparently no Director of Research of a multi-national chemical enterprise has started to synthesise a rapidly acting, powerful new anaesthetic, a peacegas, which would bring him and his company great renown and great profits.

Would such a peacegas violate the Chemical Weapons Convention? [See B.H. Rosenberg, *Bull. Atomic Sci.* 1994, 50 (5), p. 44] Under this Convention chemical agents can be developed for 'law' enforcement, including domestic riot control. But a new definition of 'law' is needed, just as much as the invention of a peacegas.

Of the many scientists, economists and philosophers I have had the privilege of inviting to contribute to the Journal, I still think that Sir Crispin Tickell GCMG, KCVO, the Warden of Green College, Oxford, was the one whose interdisciplinary ideas on mankind's future agreed most closely with mine. The reason for this I think was his deep concern about the environment and population issues, on which he spoke and published widely, and which during his distinguished diplomatic career, he brought to the attention of the highest authorities. He certainly knew the Scientific Temper.

At the time of writing his article, published in December 1994, based on a talk at the British Association Meeting at the University of Keele in 1993, Sir Crispin was Chairman of the British Government's Advisory Committee on the Darwin Initiative, Convenor of the Government Panel on Sustainable Development and President of the Royal Geographical Society. He had been *Chef de Cabinet* to the President of the European Commission, British Ambassador to Mexico and British Permanent Representative (Ambassador) to the United Nations in New York, all posts he occupied between 1977 and 1993.

In his contribution Sir Crispin, avoided predictions, but began with a general introduction outlining likely events: the widening differences between rich and poor, the relative decline of the USA [see also Title 293] and of the former USSR, the rise of Japan and the Pacific Rim, the continuing struggles in China and India, and the deepening difficulties, particularly in Africa.

He drew attention to the all-important basic fact that the world population was increasing by quarter of a million a day, 93 million per year, and that at present almost all energy consumption is derived from fossil fuels, a capital resource. The demand for energy will also increase constantly, from growing populations and their imperative demands for a better life.

An energy strategy was therefore most essential, taking account of the views of the consumers and producers, as well as of general interest. Such a strategy would favour one source of energy over another, encourage investment in promising new technologies, promote efficiency, establish national security in energy and harmonise other policies across the economy, from agriculture to transportation and pollution control. "Throughout, social cost pricing is the key" he wrote in December 1994.

Today there is a dichotomy between intellect and will, we know the answers in energy and other problems, but do not use them. "The choice is ours" he concluded.

Looking back through my diary of 1994, I cannot find any extraordinary event, no overseas visits to America or Australia, just a few to Germany and Paris, living quietly at 12 Hall Road, in London, driving my Volvo in London to scientific meetings during the day, once a week to my secretary, Mrs Ethel Lyons, dictating letters, to be signed the next week, to Heyden for the essential posting of correspondence, other office facilities and in the evening to a party or to see friends.

I was sharing a 'garden' flat, with Stefanie Maison my *Lebensgefährtin.* There is no appropriate word in English to describe this intimate relationship, neither 'Partner' (too commercial) nor 'Companion' (too vague) is adequate, while the German word, meaning 'travelling together through life' conveys best the happy co-existence without the formality of marriage.

In February I went to the Max-Delbrück Centre for Molecular Medicine in Berlin-Buch, one of Germany's National Laboratories. It is situated to the East of the city and has an interesting history. After the Franco-Prussian war of 1870-1871, the German Military High Command decided that, during the next war with Russia, the expected enemy, a very high rate of casualties was to be expected and for them appropriate hospital reception facilities had to be provided on the Eastern side of Berlin. Therefore about 1900, 25 large four-story hospital buildings were erected at Buch to serve for this purpose, but they were never used as intended. During the next War, 1914 to 1918, Germany was highly successful, and all casualties were easily treated in existing hospitals. During the following War, 1939 to 1945, when Buch could have really come into its own, German war casualties on the Eastern Front were enormous during the winter battles, but no transport facilities existed to evacuate them westwards over the more than 1000 km to Buch.

During the inter-war periods, the Buch brick buildings were used to house mental patients, and a Kaiser-Wilhelm Gesellschaft Research Institute was added to carry out research on mental diseases. During my first visit I was unable to confirm a rumours that in the Nazi period, from 1933 to 1945, brains from concentration camp victims were used for experiments at Buch. Understandably, no-one in 1994 was prepared to talk about that period.

In February 1994 I visited the Institute, now called after Max-Delbrück, and talked with its Director, Professor Detlev Ganten. I wanted to publish a special Issue of ISR devoted to the work of the Institute in particular, and to molecular biology in general. However, for financial reasons, my proposal was not acceptable, although during my discussion with a number of scientists at the Institute I had received agreements from them to contribute.

I returned to the Delbrück Center on 14 October 2000, when in its grounds a *Mahnmal* (Cenotaph) for the child-victims of Nazi medical crimes was dedicated. It was a moving ceremony attended by the Presidents of Germany's leading scientific organisations who had created this longoverdue memorial.

See Watercolour Title 396, inside Back Cover

Geneva had become for me a place of scientific pilgrimage, ever since in August 1963 I had been invited to write the ITU Centenary Book *From Semaphore to Satellite*, published by the International Telecommunication Union in 1965. [See Title 69] The World Health Organisation, WHO, also had its headquarters in Geneva and I had been a frequent contributor to its Journal *World Health*, even before writing for the ITU.

However, scientifically the most important organisation in Geneva is CERN, the *Conseil Européen pour la Recherche Nucléaire*, the European Organisation for Nuclear Research. First proposed in 1952 by I.I. Rabi, and established in 1954, it grew during the following decades to become the largest international research establishment for nuclear research, adding ever greater and more sophisticated atomic particle accelerators. It became necessary in 1965, to expand from Geneva, Switzerland, into neighbouring France, although only underground. Its membership grew beyond the original 14 European Nations.

Both, as Science Correspondent of *The Daily Telegraph* and later as Editor of *Interdisciplinary Science Reviews* I was often invited to press visits at CERN, and one of these led to a major 20-page article *CERN'S 400 GeV Super Proton Synchroton* (the SPS) in which John B. Adams FRS and seven of his colleagues described in great detail its complex, interdisciplinary design and construction. [See ISR Vol. 3 (4) p. 312 (1978)]

By the time of my visit to CERN in May 1994, the SPS had been converted into a proton-antiproton collider, leading to the discovery of the W and Z particles. The Large Electron-Positron Collider, LEP, with its 27 km long circular tunnel had been built by 1989, and its first results were shown to us.

But the most important historical event during the 1994 visit, was the establishment of the computer web, WWW, (World Wide Web), almost as a side show. I only remember the CERN scientists who originated it, Charles Llewelyn-Smith and Brian Carpenter, distributing a few sheets of duplicated paper with lists of Web sites. It has been estimated that by the time of my next visit to CERN in 1994, the Internet connected about two million computers in a 100 countries, serving some 23 million users.

These few duplicated sheets of the first web sites, well deserve to be called *THE INCUNABULAE OF THE WEB.* Do they still exist, I wonder, and where are they treasured ? Gillies and Cailliau in their book *How the web was born* (Oxford University Press, September 2000) the first 372 page-book on the History of the Web, does not even mention this first distribution to the inter-national press.

Title 398

Professor Sir Brian Pippard FRS is a Member of the ISR Editorial Board, and was the Cavendish Professor of Physics at the University of Cambridge. He is seen here adjusting the greatly improved drive and suspension, which he designed by using parametric amplification, of the Foucault Pendulum, installed in July 1988 above the 20 m high stairwell of The Science Museum, London. A review of Foucault and the pendulum's history by W. Tobin and B. Pippard appeared in ISR 19/4 (1994). *Courtesy Science Museum, London.*

The scientific institutes and laboratories I visited during 1994 were entirely of my own choice, and not because the News Editor of *The Daily Telegraph* had sent me there, as in earlier years. I was perhaps invited, and gladly accepted, or I had heard or read about some exciting new work which might lead to a contribution for my Journal. Of course, not each resulted in an article, and I would consider the chances as 50 to 50 if I was lucky—in other years it might only be much less, only 30 per cent. That my first visit to Berlin Buch was unsuccessful I mentioned on Title 396.

In April I took the train to Edinburgh for the Annual Science Festival there, but it was another failure. The various displays and events were of a very popular nature, and although they no doubt contributed much to the general understanding of science in Scotland, they were not of the standard I wanted for I S R. I enjoyed the train trip and particularly staying at the New Club, [founded in 1784, see Title 308] in Princes Street.

In May, the Science Museum in London arranged an exhibition for the Eurotunnel Company about the design and construction of the Channel Tunnel. I was impressed by the high level of interdisciplinary technology which had made this important example of macro-engineering possible, within the original estimates of cost and time, but I could not find a suitable author to write about it for ISR. I had always hoped for an invitation to visit the tunnel during the construction phase, in particular to see the giant circular boring machine, which I had heard about at CERN where it was used for their accelerator tunnels, but the Science Museum exhibition was to be the next best I could achieve.

I myself wrote an Editorial about "The great Channel Tunnel" [ISR 1996 Vol. 21 (1) p. 1] in which I expressed my admiration for this achievement. It was just one year after its completion, and the literature I had received during the exhibition I visited two years earlier, was then of the utmost value.

In September the I attended the Meeting of the British Association for the Advancement of Science in Loughborough but I did not go to Hamburg where the Gesellschaft Deutscher Naturforscher und Ärzte had their biannual show.

In October two friends came to see me in London, Robert Eisner from Melbourne and a month later William Tobin from Christchurch, New Zealand. Robbie and I were students together at Imperial College in the 1930s and he was the only friend with whom I had remained in regular contact from those far distant days. Tobin had become a physics professor and had contributed a most interesting article on "Foucault, his Pendulum and the Rotation of the Earth" [ISR 1994, Vol. 19 (4) p. 326]. I very much enjoyed seeing them both.

For this Editorial in March 1995, I took as my text a phrase from Francis Bacon of 1592:

I have taken all knowledge as my province.

I pointed out that for Bacon all knowledge was contained in the seven branches of philosophy: grammar, logic, arithmetic, rhetoric, music, geometry and astronomy. But in the total of 1700 contributions to ISR during its first 20 years, I could only claim to have published a small part of the uncountable branches of modern science, which had since Bacon been discoved.

I claimed in March 1995 to have been true to the original credo of ISR, published on page iv of the first issue in March 1976, namely contributions must be interdisciplinary from the physical, the biological, the engineering, economic and the social sciences, and I have only excluded clinical medicine. In each article, emphasis had to be placed on the link between different sciences or technologies, or on their effect on society. I admitted that I had found it difficult to find authors to communicate the cultural and intellectual links between the sciences and the humanities, and between the sciences and the arts.

I thanked the distinguished Editorial Board for their ever-ready advice and help and was glad that after 20 years, of the original 69 members, 34 were still alive in 1995. I had of course invited new ones to replace those who had died and the very few who had to resign for a variety of reasons. The list in 1995 was still 59 eminent scholars and scientists from all over the world. It was pleasant to record that many Members of the Board had become personal friends after joining the Board, if they had not been good friends before.

As some interdisciplinary subjects had proved too wide, ranging to be encompassed in a single article, occasionally a whole Issue of the Journal was devoted to a single topic. These 'Special Issues' proved very successful, and sometimes thousands of copies were printed, so that it became a tradition to aim for at least one of these in each volume. By 1995, 17 Special Issues had appeared and are listed on Title 358.

I looked ahead to the future. After the invention of the alphabet—one of man's greatest—and of printing, it would soon become possible to make all knowledge available to all, through the medium of electronic communication by the Internet. But one question remained, which I had considered in my Editorial on the occasion of the 10th Anniversary of ISR in 1985:

Knowledge comes but Wisdom lingers.

In spite of the immense growth of knowledge during the previous decades through the Internet, available to all, I doubted that Mankind's Wisdom had much increased.

Dr Joseph Needham, received in 1992—towards the end of his long life, he died in March 1995 at the age of 95—the great honour of being awarded the Companion of Honour. Earlier in his career he had been elected a Fellow of both the British Academy and the Royal Society, in recognition of his great scholarly contributions to the humanities and to science. I have never heard of anyone else who had been elected to both, the Academy and the Society. I thought right that he had been acclaimed as 'one of the greatest scholars of the century' and his *magnum opus,* the *Science and Civilisation of China (SCC),* of which by 1998, 18 volumes had been published, will rank Needham among the immortals of sinology, history and science. (See also Title 374, *Joseph Needham 90*). This obituary was published in June 1995.

I had invited Needham to join the Editorial Board of ISR at its inception in 1976, and I was fortunate enough to publish one of his most philosophically distinguished contributions on *The Evolution of oecumenical Science* in which he described the growing together of European and Chinese sciences [See ISR Vol. 1 (3)]. I was also privileged to review *SCC,* volume after volume, as they appeared almost annually from the Cambridge University Press. [See Bibliography, Appendix 2, Reviews. Title 436]. Through this often very difficult, but always most stimulating task, I became fully aware of his outstanding achievement and unique scholarship.

Sir Cyril Hinshelwood, President of the Royal Society (1965-1970), and a distinguished sinologist, reviewing Volume IV of *SCC*, wrote: "... proceed from one branch of the subject to another, then the mosaic of curious and interesting facts, the records of shrewd observations and characteristic comment, gradually build up and blend to a vivid and colourful picture of Chinese life and thought ... The picture receives life and warmth from the sympathetic understanding which the author has for the Chinese people."

Another of Needham's great achievements was his foresight and his ability to ensure the continuity of his life's work by the foundation of an Institute in Cambridge, now called after his death, the 'Needham Research Institute'. From there the remaining, at least 10 further volumes of *SCC* will be organised, written and published by a team of devoted followers. He himself collected finance for his Institute from both Eastern and Western sources.

Whenever I had the pleasure and stimulation of meeting Dr Needham at his Institute and had enjoyed his warm friendship, I came away with a feeling that it had been a privilege to know him, the greatest of the many scientists I have met in my life. His photograph and my obituary note of him, in June 1995, occupied a whole page of ISR, the only obituary of that length while I was Editor.

Roslynn Haynes: From H.G. Wells to *Australian Aboriginal Astronomy*

Roslynn D. Haynes is Professor of English at the University of New South Wales in Australia, and I met her in about 1980 during one of my visits to Sydney. Her first brief article in ISR *H.G. Wells' Contribution to Western Thought* was published in 1982 (Vol. 7, No. 2 p. 87). After studying biochemistry she took an arts degree, based on her interdisciplinary review of the works of H. G.Wells. This led to her first book *H.G. Wells, Discoverer of the Future* published in 1980 and her contribution in my Journal in 1982. We met as often as possible, always had a many interdisciplinary subjects to discuss, and thus our friendship deepened.

Her second publication in ISR (Vol. 14, No. 4 p. 384, 1989) had the title *The Scientist in Literature—Images and Stereotypes—Their Importance*. This time it was the article in my Journal which preceded her beautifully written 417-page book *From Faust to Strangelove.* This appeared in 1994 and was a very scholarly and much researched expansion of her ISR article and a unique contribution to the scientific literature. For her book, I was able to lend her two original 19th century aquatints from my own collection.

Married to the astronomer Dr Raymond Haynes, Roslynn obviously shared with him an interest in astronomy and was already in 1989 collaborating with him on a history of Australian (Western) astronomy for Cambridge University Press. During this scientific partnership, it must have struck them both that their history would not be complete without a chapter on Australian aboriginal astronomy, and once again my Journal benefited.

In December 1995, I was able to publish *Dreaming the Stars—the Astronomy of the Australian Aborigines* (Vol. 20 No. 3 p. 187). It was another uniquely interdisciplinary subject, never before discussed anywhere in such detail. Once more it enriched my knowledge and that of my readers. One of them, Adrian Berry, condensed her article in a lengthy press report for the London *Sunday Telegraph* of 1 October 1995.

She considered the precise observations of the Aborigines as conceptual, rather than perceptual, and the legends which embodied their astronomical knowledge functioned as a predictive calendar for terrestrial events. They also contributed to a philosophical rationale for a tribe's understanding of the Universe, and they were associated with stories which reinforced the moral values of a tribal identity. Traditional bark paintings, reproduced for the first time in the article, provided examples of the legends.

Using the photon-wind from the Sun, analogous to terrestrial sailing, as a propelling force to sail a spacecraft from Earth on its mission, is neither new, nor science fiction, nor theoretically impossible, as the first experimental preparations have already shown. These were reported by Dr C.R. McInnes of the Aerospace Engineering Department of the University of Glasgow in a complete and up-to-date review of the subject which contained much that was new to me and I hoped also to my readers. I published it in December 1995.

The actual concept of solar sailing is due to the Soviet father of astronautics, Konstantin Tsiolkovsky who wrote in the 1920s about "using tremendous mirrors of very thin sheets to attain cosmic velocities". I first read about Solar Sailing in Arthur C. Clarke's exciting short story in which he described a thrilling international race to reach the Moon by solar sail spacecraft during which astronauts from different countries, by means fair and foul, tried to win the race. It was not mentioned by McInnes.

It was not until the early 1970s that the Space Shuttle, allowing the transport of bulky payloads and their deployment in space, suggested to NASA that solar sailing could be considered for certain missions. At their Jet Propulsion Laboratory in 1976, an initial design study was undertaken for a 800 × 800 meter square sail for the Comet Halley rendezvous mission. However, it had to be abandoned because of the high risk of its deployment. As an alternative, a spin stabilised heliogyro was considered which was to use 12 long blades, each 7.5 km long. Its advantage was that the blades could easily be deployed by simple unrolling. These NASA studies of solar sailing created worldwide interest and led to further experiments, particular of the solar sail material.

The JPL sail material was composed of a Kapton plastic film, 2 9 m [2 micro meter, or 2 millionth of one meter] thick on which a 0.1 µm layer of reflective aluminium is deposited, and backed, on its rear, with a layer of chromium of 0.175 µm thickness for thermal control. Such a sail, it was hoped, could be easily folded and deployed in space without difficulty. Cambridge Consultants Ltd of England, also developed a solar sail of a 276 m diameter disc, which was considered in 1995 the most advanced type.

McInnes discussed the great advantages of solar sail propulsion, as it needed no propellant and as it provided constant acceleration. It would prove very useful for inner solar system's missions, as for example a four-year round trip to Mars and back, or a mission with a 10 ton payload into orbit around Mercury in 900 days or 2½ years. Other solar system missions and advanced solar sail missions were described. No doubt, a great future awaits the solar sail.

ISR 21/1 *Derek de S. Price—Historian of Science* Title 403

I was Derek Price's "oldest friend", as the three authors, all Professors of the History of Science, pointed out in their review of his scientific life's work. The leading author was Professor Eri Yagi of Toyo University, together with Lawrence Badash of the University of California, Santa Barbara, and Donald Beaver, Williams College, Massachusetts—all three having been students of Derek Price. After his fourth heart attack and death in 1983 in my London flat during a brief visit, there were numerous obituaries [see reference 7 of the ISR article, published in January 1996] but I considered none of them adequate for his pioneering contribution to the history of science and to scientometry. When in 1992 during an exchange programme, Eri Yagi delivered a lecture on Derek Price at the University of Strasbourg, I invited her and her colleagues to write a paper for I S R.

I got to know Derek in the early 1950s, and when I was Editor of *Discovery* [Title 62] he published in 1956 "The Prehistory of the Clock". He described the Greek gear movements of what became known as the 'Antikythera mechanism', of about 2000 years ago. It revolutionised our thoughts about the technical achievements of ancient Greece [See *Discovery* Vol. XVII (4), p. 153].

Derek moved from London University where he obtained his B.Sc. and his first doctorate, to the University of Singapore as lecturer in applied mathematics at the age of 28 and there developed his idea of the 'exponential growth of science'. Returning to England, he devoted himself to the study of scientific instruments at the University of Cambridge, and obtained his second Ph.D. in the History of Science. In 1957, aged 35 he went to the USA, first as Consultant to the Smithsonian Institution in Washington DC, then as a Fellow of the Institute for Advanced Studies in Princeton and in 1960, aged 38, to Yale University, being appointed the first Avalon Professor of the History of Science. He remained there until his death, when he was 61 years old.

Among Derek's many contributions to science was his discovery of Chaucer's *The Equatorie of the Planetis,* his *Chinese Astronomical Clockwork* in collaboration with Joseph Needham, an *International Checklist of Astrolabes* in 1956, which is still today unequalled. In *Discovery* [1956, XVII, 240] appeared "The exponential Curve of Science", and in the same volume [unsigned, p. 159] "The Science of Science" which began his great contributions to scientometrics, of which the three authors called him rightly 'the Herald' in the title of their article. The 240 references to his articles have to be read to appreciate Derek Price's erudition and scholarship in the History of Science. I published this memorial note in January 1996; see also the next Title 404.

My Friendship with Derek Price Title 404

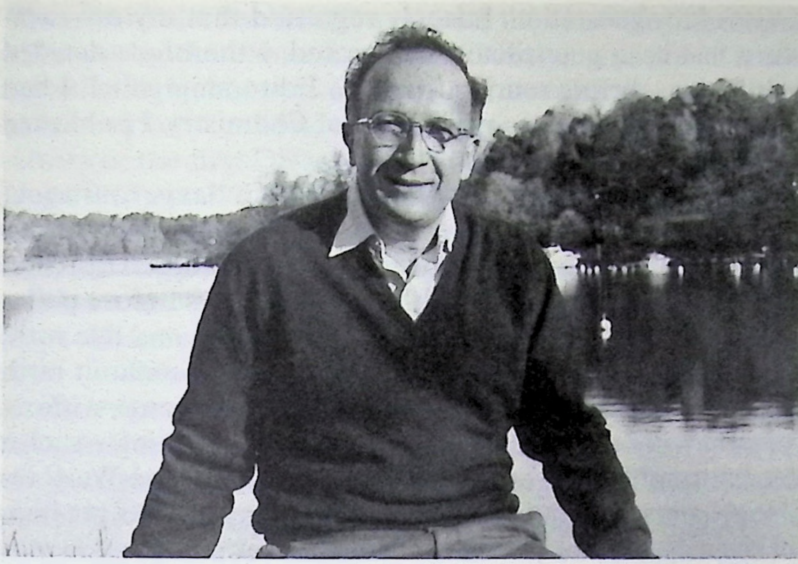
It is now more than 50 years ago that I met Derek Price, but I do not remember precisely where and when. We first came across each other perhaps as Editor and author, we first talked to each other in a formal relationship, not 'love at first sight'. He had just returned from his lectureship in Singapore, and I was finding my feet as an Editor, feeling proud in my new job at *Discovery.*

We had something in common right away, I had returned from Australia in 1954 and he from Singapore at the same time. There Price had met Cyril Parkinson of 'Parkinson's Law' fame, who was the Professor of Naval History at the University. From him, Derek got his first inspiration to study history. We must have talked a lot in London about the technological history of the Navy and its relationship to scientific invention as well as their influence on naval warfare, a subject about which he was very knowledgeable at that time. The history of science and of technology were to be one of our many common interests during the next 30 years of our friendship.

Derek was extremely gifted, with great charm for both men and women, when he chose to let it play, and above all ambitious. From his father, a Jewish Ashkenasi tailor in the East End of London, he had inherited no worldly goods, but a penetrating mind which brought Derek world renown in his two fields of History of Science and Scientometry. He could express himself with great ease and wit, he coined new phrases and words at the slightest provocation, and his neologism of "Big Science" in his book *Little Science, Big Science* (1963) became a world concept.

I could never equal him in these respects. What we both had in common was a love of collecting the 'antiquities of science' ranging from Astrolabes, antiquarian books, instruments and mostly the medals of science [Title 74]. There I could excel Derek, as it was easier to follow this pursuit in London than in the USA, and often I was able to show Derek my finds, which he then explained to me in scholarly detail. We exchanged duplicates, whenever possible, and competed to acquire the best scientific antiques.

Our friendship was a close one, although it was based on intellectual scholarship, where he was the master and I his student. It lasted for 30 years, although an ocean often separated us. His erudition inspired me and I learnt much from him, not only in factual knowledge, but also in philosophical attitudes, greatly enriching my life in a way he had also fertilised so many others. His early death saddened me deeply, and I had to arrange his London cremation and funeral in 1983. Only a small plaque at the Golders Green Cemetery remains as a physical memento of this unique historian and great man of science. His numerous publications will serve as his lasting memorial.



Title 405

Professor Roald Hoffmann, Nobel Laureate 1981, is a Member of the ISR Editorial Board and now the most interdisciplinary chemist I know. Born in Poland, he went to the USA in 1949, and since 1965 has been Professor at Cornell, holding the two chairs of Humane Letters and 'Applied Theoretical Chemistry' as he likes to call it. His published poems and his books like *Chemistry Imagined* and *The Same and Not the Same* are full of the Scientific Temper and in praise of chemistry. ***Photograph by Courtesy of Eva B. Hoffmann.***

Like many other chemists of my generation, I deeply regretted that my own academic subject, Chemistry, had been unjustifiably denigrated. I therefore decided that my last major contribution—before retiring from the Editorship which I had enjoyed for 20 years—should be devoted to a vindication of Chemistry. I published it in June 1996, my last ISR article as Editor.

Chemistry began when men and women learnt to master fire, a dangerous agent unless carefully controlled. But ever since then, a continuous improvement of our life on Earth can be traced, in which chemistry has been rightly considered the chief agent for this progress. Although the cry "return to the good old days before pollution" is still heard, no one wishes to go back to the smoke—filled cave and live without anaesthetics, without pharmaceutical drugs to remove pain, and without birth control pills, without cheap fuel to drive cars, without soap and detergents, without the safe preservation of food, without central heating and air conditioning—such a life is today unthinkable for the affluent West. 'The good new days of the West' remains the most desirable progress for thousands of millions who cannot as yet benefit from these fruits of chemical discovery.

I discussed 'evil chemistry' in my ISR review, the use of poison gas by Germany in World War I and in 1983 by Iraq [Title 159], the use of chemical defoliants by the USA in the Vietnam War and the shocking use by Japanese terrorists in 1995 of the nerve gas sarin in the Tokyo underground system. Equally 'evil' is to my mind the use of chemical knowledge to extract, prepare and refine hallucinogens, narcotics and synthetic drugs, which I called *Religion's chemical Surrogates*. [See ISR Vol 15 (2), p.97, 1990 and Title 373]. The only possible chemical answer to the worldwide drug menace, is the synthesis of a 'Soma', as Aldous Huxley called it in *Brave New World,* an ideal stimulant without undesirable after-effects, a 'socially-sanctionable drug' as Matthew Huxley, son of Aldous, proposed. [See ISR Vol 1 (1), p. 176, 1976 and Title 264]

I also discussed 'disaster chemistry', the explosions which have—and will—occur when basic precautions are not applied, when a chemical production plant is not in perfect condition, and when operatives are not highly trained. When an accident has occurred, a highly efficient and fully trained rescue service must be instantly available, if a minor incident is not to become a major accident. [Title 292]. I called these conditions the sequence of the 'Implacable Law' [see Title 343] of all high-technology disasters and I gave a table of recent chemical disasters. [See ISR Vol. 21, No 2, p. 133] The worst of all was the escape of methyl isocyanate gas from a Union Carbide plant at Bhopal in 1984, killing 2500 people and injuring a quarter of a million. In comparison the other chemical disasters killed perhaps 'only' a few hundred. [Title 343].

'Chemical Pollution' is often given as the reason for chemophobia and in particular pollution by the exhaust gases of Diesel-engine driven trucks. The exhaust gases from the high chimneys of industrial factories are not noticeable from the ground, unless coloured yellow, when dangerous but now very rare. When the 100th anniversary of the first Diesel Engine occurred in 1994, I drew attention in my Editorial [Vol. 19 (3), p. 177 and Title 393] to the fact that the modern Diesel engine, when well adjusted and properly maintained, does not produce any pollution. Strict legal ordinances try to prevent this exhaust in the Western World.

If here, and in my review of 1996, I devote much space to discussing 'Evil Chemistry', 'Disaster Chemistry' and 'Chemical Pollution', it is to show that negative aspects of Chemistry exist and are well-known to Chemists and the public. What is hardly ever acknowledged are the enormous benefits of Chemistry which all of us enjoy to the full, living at the high standard of modern civilisation. I devoted 5 pages in my original review [ISR 21/2] to what I called 'Beneficial and Essential Chemistry' which have brought irreversible changes to all mankind. Here I can only repeat a short list of these.

As most essential I considered the refrigeration of food. That this has been, and still is, carried out by using chlorofluorocarbon compounds, which are colourless, odourless and non-toxic to man, is due to the fact that their destruction of the ozone layer surrounding our planet has only recently been discovered. Industrial research is now looking for a wider application of harmless alternative chemicals.

As most beneficial I considered the contribution of chemistry to modern sports equipment. Obvious examples are carbon-fibres embedded in polymer matrices, producing materials for racing bicycles, racing cars and tennis rackets, lighter and stronger than those originally used. Heavier chemicals had to be found to replace the now illegal ivory billiard balls, but contra, yachtsmen prefer the lighter and more flexible nylon to the heavy natural fibres for their ropes and sails. Using human sports performance enhancing chemicals, such as steroids and certain hormones, must be condemned.

Essential is the universal washing of body and clothes, whether 'natural' soap (of course chemically produced and purified through saponification) or synthetic detergents are preferred, the latter now produced industrially, as a multi-million ton product. Beneficial is the ingestion of alcoholic liquids in moderate quantities, and again chemistry, in the fermentation process transforming sweet fruit juice into alcohol, is the essential process. Because fermentation is so successful in producing wine and beer, it has remained basically unchanged since its accidental discovery thousands of years ago.

Is the fear of Chemistry, Chemophobia, important? Or is it merely a fashionable attitude, which can be disproved like the Flat Earth Hypothesis? Rachel Carson's book *Silent Spring* started international environmental concern in 1962 and in consequence it enhanced chemophobia. The major argument has been that the chemical industry placed profits before environmental concern, but this is no longer so cogent as it was in the past. Chemical companies have now realised that their sales performance is reflected in their public image and small efforts have begun to counteract chemophobia.

Certain blame for chemophobia must also fall on the media which have seen in the negative aspects of chemistry the source of sensationalised reports, based on misleading facts and gross exaggerations. As I was the Science Correspondent of the London *Daily Telegraph* for 10 years, I am fully aware of the difficulties of reporting chemistry in a daily newspaper to a readership, unaware of the difference between a chlori<u>de</u>, [harmless as common salt] and chlori<u>ne</u> [the first poison gas ever used].

The real harm of chemophobia resides in the totally negative attitude injected in young children and students, avoiding the choice of chemistry as a career. Eloquent proof resided in 151 'chemistry drawings' produced by children from Basel, the city where Switzerland's chemical industry is concentrated [See ISR 21/2]. The great majority of children felt threatened by chemistry, symbolised in their drawings of skulls, skeletons, TNT and other explosives, and above all by the thick black smoke emanating from factory chimneys. Such attitudes are accurately reflected in the declining number of chemistry students at Universities, a fact which did not escape the attention of chemical companies in the West, afraid of losing able chemists for their own future industrial employment. As it stands, chemical industry in the East is strongly competing for young qualified chemists, as there chemistry is still considered one of the best careers for talented male and female students.

The answer to chemophobia appears simple. When gifted and enthusiastic teachers of chemistry, themselves inspired by the galaxy of the great chemists of the past, can transmit to their students the attraction of chemistry, then the best of the next generation will choose chemistry again as their career. I did. [See Title 4]

Teachers are notoriously underpaid, and chemistry teachers are no exception. The 'Fonds of Chemical Industry' started in 1950 by Otto Bayer in Germany is the example to be followed. Collecting 50 Pfennig for each employee in the Industry, it raised DM 160 million in 30 years, and thus could implement the income of the best university students and university teachers. It is time to start a similar Fonds for school teachers of chemistry, and thus *<u>Stop Chemophobia.</u>*

For some years it had become obvious to my *Lebensgefährtin* and myself that our garden flat in London would not be an ideal home for our old age. As I had reached the age of 80 in 1996, and Stefanie was only a few years younger, the time had come to pass from the planning stage to action. The essential first step was to find an alternative home, as comfortable as we could afford, where medical services might be available, when the inevitable need for them arose.

The old-age residences we looked at in England did not come up to the standard we envisaged, and we were forced to turn to Germany where there existed a choice between a number of *Augustinum* [see below]. I also had to give the Publishers of my Journal an indication that I could not continue to function as Editor, if I lived 1000 km away in Germany.

My choice of successor had fallen on Joseph Coates, together with his very able wife Dr Vary Coates. Both were good personal friends, had been contributors, Joe had been a member of the Editorial Board for many years, and both were enthusiastically in agreement with the interdisciplinary policy of Editorship. However, they lived in Washington DC, USA. I pointed out to the Publishers, the Institute of Materials, that modern electronic communications would make it easy for the Coates's, with their staff, their large office and its manifold facilities, to edit ISR more efficiently than I had ever been able to do, with no staff and no office. However, the Publishers' conservative attitude was against my choice.

At the Editorial Board Meeting on 25 July 1996, for which Joe and Vary had specially flown over from Washington, I announced my retirement and was appointed Emeritus Editor. The Publishers named my successor, Professor Jack Harris FRS, a Metallurgist, who was well known to them through his science writing and editorial experience, and I can now state that it was a good choice which justified his selection, although I would have preferred the Coates team.

At the Meeting, Members thanked me for my work and urged me—in vain—to continue. The Publishers had kindly arranged to reprint *Interdisciplinary Thoughts* of 1986, an Anthology of the Editorials I had written during the first 10 years, as Editor [Title 345]. They also added the Editorials of the following 10 years. They called it *Interdisciplinary Thoughts 1976-1996* and stated at the foot of the title page "Published in a limited edition to mark his retirement as Editor of *Interdisciplinary Science Reviews,* July 1996". Professor Sir Hermann Bondi, KCB FRS wrote a very complimentary introduction, which was signed for me by all present at the Meeting.

Continuation of ISR — Title 409

Having officially retired as Editor in July 1996, the next Issue in September carried the Announcement: "EDITOR Professor J.E. Harris, MBE, FEng, FRS, FIM" and "EMERITUS EDITOR Dr. Anthony R. Michaelis".

Jack Harris called his first Editorial "Antarctic Research and the Earth's Environment" and started it with a paragraph he entitled "Michaelis's early life". He called me a 'a great crosser of boundaries', whether of those separating scientific disciplines, cultures or nations and, amongst all my travels the one he envied me most, was my visit to the South Pole. He therefore chose *Antarctic Research* as the subject of his first Editorial.

In his interdisciplinary survey Harris began with Spufford's book *I may be some time: Ice and the English Imagination* (1996) which had been called a 'classic repertoire of polar literature'. Harris commented that British Antarctic exploration had been more marked by bravery, than caution or wisdom, a true statement affecting the 'heroic period' of Antarctic exploration, but no longer applicable to British research in the Antarctic of today.

He went on to describe *Lake Vostok*, 4 km below the Antarctic ice surface and containing fresh water, which might be one million years old. It was discovered during a British radar ice survey [Title 201] and is of great interest to microbiologists, anxious to find, if hitherto unknown ancient microbial life exists in the Lake.

Next Harris turned to the pollution of the Antarctic atmosphere caused by gaseous chlorofluorocarbons and the resulting Ozone Hole. Global warming results from pollution by carbon dioxide and at present the level is about 360 ppm. The ice core drilled above Lake Vostok showed that for the last 160000 years, the small air bubbles contained in the ice, never had more than 300 ppm carbon dioxide enclosed in them. Obviously the increase resulted from the burning of fossil fuels by man. The first editorial by Harris concluded with the hope that more environmentally oriented research in the polar regions be encouraged. I agreed most whole-heartedly.

After the first Issues of ISR edited by Harris, there can be no doubt that the Journal will continue with its interdisciplinary policy. There are two guarantees: First he is a fellow of the Royal Society and thus will have a good chance of acquiring excellent contributions from its Fellows, representing the whole spectrum of the physical sciences. Secondly, as a member of Pugwash, the almost secret international group of scientists devoted to using science for the benefit of mankind, the Scientific Temper. Harris will therefore publish material that supports Pugwash. I shall certainly continue to read ISR with pleasure, without the effort of having to produce it!

When Germany had begun to overcome the after-effects of the war lost in 1945, a remarkably rapid period of recovery, the so-called *Wirtschaftswunder,* occurred. It was greatly aided by American Marshall Aid in 1948. The currency was stabilised and the influx of millions of US dollars led to industrial and social changes. Konrad Adenauer as the Chancellor of West Germany had as one of his political aims an extensive building program, with preference for the middle classes, which had suffered so extensively through the nation-wide destruction of houses and homes.

It was a Protestant Clergyman, Georg Rückert, who realised that novel ways of Christian Care had to be explored during this period of great sociological changes in Germany in the 1950s. One of these, common to the whole Western world, was the inability, or even the unwillingness, of the younger generations to look after their aging parents, as large family homes, suitable for two, three or even more generations, had become financially impossible in European and American cities. This age-old tradition of generational co-habitation has, however, survived in the East and in a few rich Western families.

Rückert was inspired in his work by Aurelius Augustinus (354-430 AD) the great early philosopher of Christianity who for a time was the Bishop of Hippo Regius, the modern Annaba on the Algerian coast, then the Roman Province of Numidia. Many of his writings have survived and were translated, and he is generally considered as one of the Fathers of the Christian Church. The basic principle of his entire theology has been described as the 'outgoing energy of creative love' [*Encyclopaedia Britannica 15th Ed. Vol 14*].

Beginning in 1954, at the 1600 Anniversary of the birth of Augustinus, with a Protestant Students Home in Munich, the concept of a 'Collegium Augustinum' was expanded by Rückert to include an 'Old-age Residence Foundation', a *Wohnstift,* and by January 1962, the first resident moved into his apartment at the first Wohnstift, built at Neufriedenheim in Munich.

The novel idea of the Wohnstift, providing Freedom and Independence, yet Security in old age, while living in a Community provided with rich cultural events, proved so successful that these Institutions multiplied rapidly in Germany (one in Austria) during the last decades of the 20th century. By the year 2000 there were more than 22 of these multi-unit apartment buildings from Hamburg in the North, Bonn in the West, to Berlin in the East and Vienna in the South. The almost luxurious comfort, providing for the upper middle class the highly desirable alternative to generational co-habitation, has made the Collegium Augustinum a sociologically successful innovation.

Stefanie Maison and I, having heard of the successful German Augustinum Wohnstifts, searched in vain for an English equivalent. Had we found one, we would never have left England, where we had both been so hospitably received as refugees and where we had lived, and after naturalisation, worked so happily for over 60 years as British Citizens. We have remained British and re-aquired German nationality.

The idea of a return to Germany, the place of our births, was deeply overshadowed by our aversion to a country that had expelled us in 1933 under such terrible conditions. Stefanie's mother had died in a Concentration Camp, and my father had to flee penniless shortly before the outbreak of World War II. For the third time in his life, he had lost all his savings in Germany. The first was worthless bonds of World War I in 1918, the second time during the hyper-inflation in 1923, and in 1938 by confiscation from the Nazis.

Nevertheless, we decided to explore the Augustinum in Munich, Freiburg and Heidelberg and decided on Heidelberg, the ancient and pleasant University town in Southern Germany. A Wohnstift Augustinum had been built there in 1975 as a multi-unit apartment building, a condominium, located about 7 km south of the old city centre. Situated in a suburb, it is partly surrounded by the trees of the Odenwald and partly by vineyards. When we first visited it in February 1996, we were lucky and a superb three-room apartment on the 12th floor with magnificent views was offered to us.

Although we were not ready to move for several months, we decided there and then to take it. Apartments in an Augustinum are not cheap, and the first down—payments is for a Home Loan, repayable on giving up residence, almost always because of death.

In addition a monthly rent is payable, as Home Loans are the working capital of the Collegium Augustinum, a Protestant, non-profit making, registered Association which is required by law to use any profits for the maintenance and improvement of the buildings and their facilities. After several years of residence, I can confirm that the facilities provided at the Heidelberg Augustinum, such as indoor swimming pool, theatre, concert and cinema performances in a large hall, denominational chapel and a bowling alley, provide a very pleasant retirement.

For me it offered the ideal background and facilities for the writing of this book which was entirely undertaken here in Heidelberg, having brought with me all the essential historical documents. The cultural diversions on constant offer include lectures on a great diversity of subjects, exhibitions of contemporary art and organised excursions to far and near.

APPENDIX (I) My Parents and early Berlin

Only now, in the quiet of my new study in the Augustinum, have I found the peace of mind to think of my parents, to whom I owe everything. I have therefore decided to write a few pages about them.

My mother died of pneumonia in the summer of 1929, when I was 13 years old, in the Landgrafen Strasse 10, Berlin. This was the apartment in which my parents had lived since they were married in about 1910, and where I was born, our real home. My last memory of my mother is of her lying peacefully in bed. Many years later, when I learnt that Gerhard Domagk had discovered in 1932 the first sulphonamide, prontosil, which would have cured her pneumonia, I could not overcome my resentment that, had his discovery come five years earlier, it would have saved my mother's life.

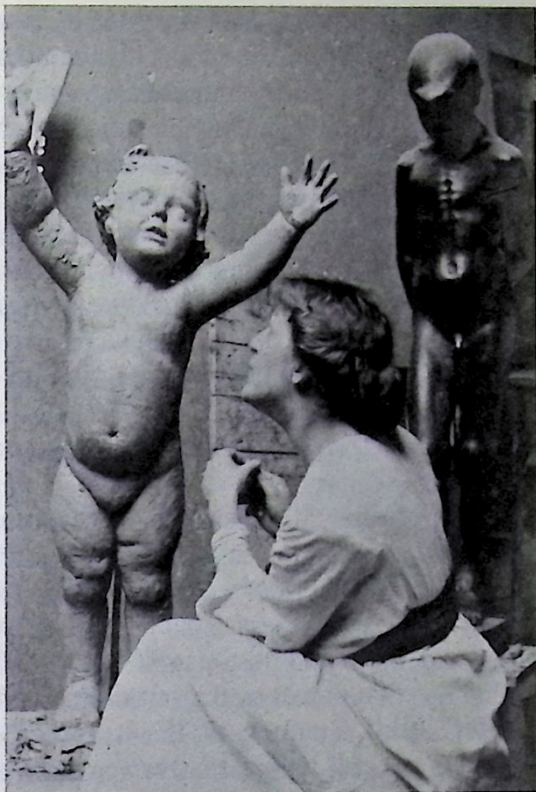
My mother was *'eine treffliche Berliner Bildhauerin'* (a splendid Berlin sculptor) as she was described in one of the many press notices published in 1912 on the occasion of the exhibition 'Women at Home and in their Professions'. This Berlin Exhibition had an art section in which my mother showed two sculptures, a boy in bronze and a young woman in marble both life-size. She received for them one of the five prizes awarded by the Committee and hence her name appeared in 17 Berlin and provincial newspapers, as well as in a Paris journal. She must have subscribed to the Berlin Press Cutting Agency, the 'Literary Bureau', because I still have the cuttings, slightly discoloured, now lying in front of me.

Later in the same year, my mother sent two sculptures to Paris, to an Exhibition of the Société Nationale des Beaux-Arts, which honoured her by making her an honorary member. She had already shown her work at the Leipzig Annual Art Exhibitions of 1908, 1909 and 1911, as recorded in the *Norddeutsche Allgemeine Zeitung* of Berlin.

It is most remarkable that in spite of the severe conditions of World War I in Berlin, the annual "Great Art Exhibition" took place and my mother was able to exhibit in 1915, when she received mention in seven newspapers and in 1916 again with three mention and in 1918 with one. As the reporters wrote, the exhibitions were getting smaller and smaller, and this also explains fewer press notices. All these were lovingly preserved by my father and have thus reached me now, after nearly a century. I am also certain that my mother showed a new sculpture on each occasion and this was a great achievement to have created them during the war years. They earned her the description *'grossartig'* (splendid, magnificent).

Title 413

An "excellent Sculptor" as the Author's mother, *Martha Bauer*, was described in press notices after her exhibitions. ***Author's Collection.***



My Mother's Sculptures Title 413

My mother's maiden name was Martha Bauer (later Marta) and she was born on 9 June 1888 in Berlin. She was christened, was of Lutheran faith, and brought me up in the same. [Title 4] She was very musical and often played the grand piano at our home. Arthur Schnabel, the famous pianist, married a singer and whenever she was singing, my mother acted as her accompanist. In due time they became good friends, and I was expected to play with the two sons of the Schnabels, until one day the younger dropped a heavy weight on my foot, and although nothing was broken, the resulting pains have made the Schnabels unforgettable.

But being a sculptor was my mother's vocation, and for her work she had a studio and professional models. I have two photographs of her in a white working smock one with her hands full of clay, working on of a small child, almost complete. The other photograph sculpture modelling a plaster cast of a girl with flowing hair. This was her normal style, clay first, then plaster cast, and finally, when called for, a full-size bronze sculpture.

I have no idea how many major sculptures she produced during her life and have proof of only one sale, to the Duke of Schleswig-Holstein. A letter from one of his court officials to my mother, dated June 1908, states that the Duke "has graciously agreed that the marble figure he bought, may have a small plinth". In the same year, the New Photographic Society of Berlin published a series of postcards, calling the 'Sculptures by first-class Masters'. I have three of these postcards of my mother's work, Numbers 10, 18 and 122, all designating 'Marta Bauer, Berlin'. The second, a portrait bust in marble was, with the artist's signature, worth 2000 Mark in 1907, as my mother proudly wrote on a postcard which she sent to her sister living in America.

The third, showing a nude woman in bronze with her two arms touching her ead, has an interesting history. It was called *Dance,* stands 50 cm high and I have a bronze cast in my study. Her story was told me by my Godmother, Dora Pellnitz, when she was 102 years old and when I met her again in Berlin after World War II in 1945. She was my mother's best friend and they studied together at the Berlin Art Academy. Their parents gave each of the two girls totally 1000 Mark and let them travel through Italy unaccompanied in about 1905 (!).

At Capri they went swimming and they saw each other in the nude for the first time. This inspired Dora, a painter, to do some drawings, which she found again in 1945 and gave me for my two daughters in Australia. The swim prompted my mother to give *Dance* the body of Dora, and she presented it to her in marble. During an air raid in Berlin in 1943, it fell to the floor and lost its two arms. Later her son Dietrich Pellnitz and I had three copies cast in bronze, two for his sons and one for me.

Dr. med. Walter Leopold Michaelis was a medical specialist for children's and internal diseases, and thus he described himself at the top of his prescriptions. My father, born on 3 November 1875 in Berlin, was Jewish, but not practising his faith. Nevertheless he suffered severely for it, as all German Jews did after Hitler came to power in March 1933, and he was lucky enough to escape to England in 1938. He committed suicide in London on 9 July 1940, as I have described in Title 21.

He was 13 years older than my mother, and as long as she was alive, till 1929, his life and that of my mother's must have been a very happy one, as far as I can judge from my memories and from their still extant letters. I know nothing of his student days at the University in Berlin, but they led to a degree of Doctor of Medicine and Surgery which he received in February 1898, at the age of 23 [Title 333]. His first 10 years of medical practice could not have been easy, as his engagement to my mother was not announced until 1908, 10 years later, when he was 33 years old.

They must have known each other since 1904, as I have a number of postcards from that date onwards, written by my mother and at first very formally addressed to my father with '*Sie*'. The Imperial Mail Service was certainly very efficient in those days, as on postcards dated 1905 and 1906, arrangements for meetings were made for the following morning. "Dont know if I can meet you tomorrow morning, I shall have to buy something to wear" my mother wrote on 5 June 1905. Postcards to each other from holidays have also survived from that period.

I shall try to reconstruct the life of my parents, and the picture of Berlin, during those years which ended in April 1917, with my father being called up for Medical Service in the German Army and being posted to Brussels then German-occupied.

My father must have had a difficult time starting his medical practice after his marriage, about 1910. Patients must have been few and income limited from his fees, and although my mother must have sold occasional sculptures, this could not have amounted to very much. Nevertheless, they moved to a large flat, Landgrafen Strasse 10, where he saw his patients during the afternoons. During the morning hours, he visited them in their homes. What must have greatly helped him throughout these early days was the telephone, which in 1910 was still a relative rarity in private homes.(See my book on the History of Telecommunications, Title 69). It began to be used by rich people, and hence from the beginning of his professional life, his well-to-do patients were able to reach him easily and avail themselves of his services.

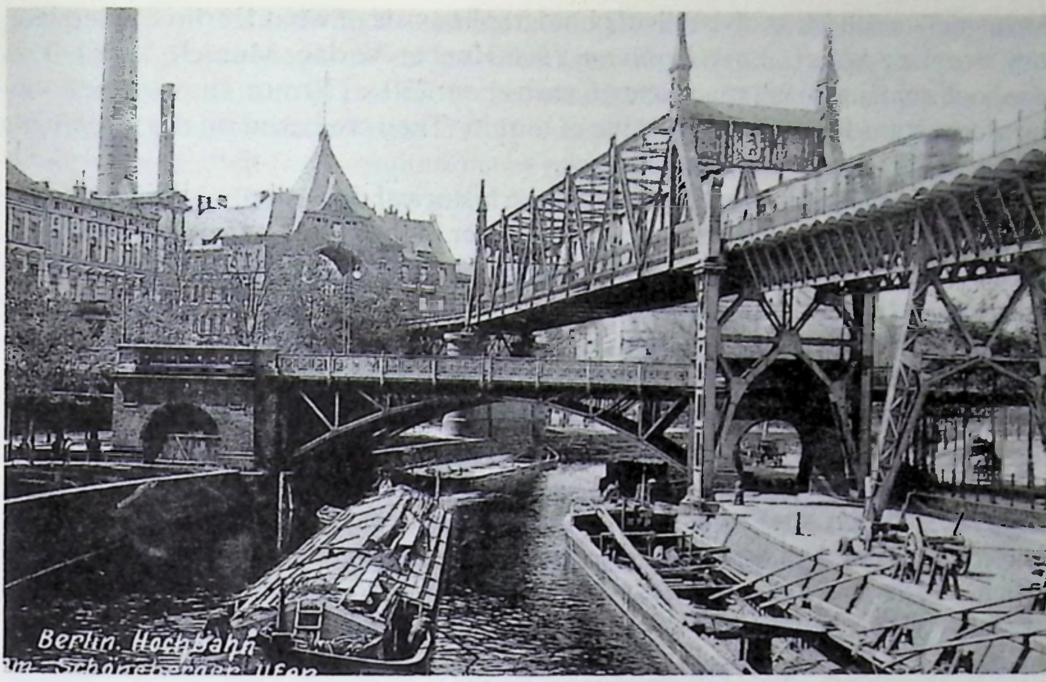
Berlin was the Capital of the Kaiser's Germany in the first decades of the 20th century, when my father started to practise medicine from his home. The society in which he lived and worked was a very stratified one. The Kaiser, his courtiers, the hereditary aristocracy and the Prussian Military were the very top caste, below them wealthy industrialists, then the professional classes with University Professors considered the elite of that caste. Employees, civil servants and the lower middle classes followed in this hierarchy, with the working classes at the lowest level of this structure.

Upward movement, driven by ambition, greed and need, was rare, slow and difficult, although there were few official barriers. Jews, however, were barred from certain professions, from a military career, and only a very rare minor elevation to the lower aristocracy occurred, when the title *von (Freiherr)* was bestowed, for example, the owner of the private bank Franz von Mendelssohn, whose family however, had been christened a century earlier.

My father's patients belonged to the professional middle classes, with perhaps an occasional exception, above or below this stratum. More frequent, in his later years, were patients from the American and British Embassies, and there was also the occasional *Freiherr* and *Freifrau* . Similarly, his circle of friends belonged to the professional middle class, again with the occasional exception like the Mendelssohn family, who were both friends and patients. It appears to me that in those distant days of class distinction and great dangers from any serious illness, friendships between doctor and patient often grew very quickly from medical consultations. I remember that just before Christmas, many presents arrived at home, particularly wines, bottles of liqueurs and other delicacies.

A further reason for this often close medical-social relationship was the fact that my father visited the homes of his patients, mostly children, and thus soon became well known to their parents. In case of urgent need, a telephone call from a harassed mother in the middle of the night was always immediately followed by a visit to the bedside of the child. How my father travelled in the middle of the night through the Berlin of those days can now only be reconstructed in my imagination.

I do know that my father never owned, nor drove, a motorcar throughout his life. With public transport shut down at night, he must have started walking and considered himself lucky if he found a horse-drawn *Droschke,* a taxi, that took him to his destination. No wonder, that grateful parents or patients, sent him lavish Christmas presents.



Title 416

The *Gleisdreieck* in Berlin 1910, where the author's father was nearly killed when an *elevated* train fell from the top of its trestle of three transport levels which gave this traffic junction its name. Luckily he was unhurt and was able to give first-aid. *Courtesy Sammlung Eickemeyer Berlin.*

Fortunately, a collection of excellent photographs exists of what Berlin looked like, now a century ago. (L. Levy *Berlin um 1900* Hueber Verlag, Munich, 1986). This rare book contains 70 full page pictures, each about 230 × 170 mm, showing not only the architecture, but also the street life of the city. They are based on the *Archiv für Kunst und Geschichte,* Ismaning, Munich.

The first impression, when looking at these historical documents, is of the emptiness of the broad streets and avenues in the center of the city. All traffic is still horse drawn, from the occasional elegant equipage, with its two top-hatted grooms, the horse-drawn tramcars running on rails, the *Droschken* (taxis), and the heavy goods carriages, all relying on animal power. Even a dog-drawn cart with its load of vegetables for domestic consumption can be seen. I found no single automobile on these 70 photographs of 1900, although the first few cars were by then owned by rich and enthusiastic amateurs.

The public transport by Metro Line was much admired in Berlin. It was running as an Elevated on huge iron and masonry support bridges for many kilometers through the center of the city. It then submerged below ground and finished in open trenches towards the suburbs. At one point there were four traffic systems, one above the other; below the Elevated ran the Main Railway line, then below the road system and still lower the Landwehr Canal with its many long barges. All these are still in existence now and much used.

This crucial crossing was famous and is called *Gleisdreieck,* the 'triangle of rails'. There, on 26 September 1908, at a junction of two elevated lines, a collision occurred between two trains, and several carriages fell from their elevated rails to the ground below. By misfortune my father was travelling in one of these carriages, and miraculously was unhurt, able to give first aid to the many injured, in spite of the severe shock he must have sustained himself. My mother's horror, just about a week before the announcement of her engagement, can be imagined, when she heard of my father's involvement in the accident, until she was informed of his extremely lucky escape.

The second impression of the historical photographs is of the monumental prestige buildings on nearly all photographs, obviously the choice of preference for the photographer. Some of these buildings still exist a century later, no doubt much restored or even rebuilt after the destructions of World War II. Today they are equally impressive, as I found during my recent visits to Berlin. There is first the famous *Brandenburger Tor,* then the *Reichstag*, the *Kaiser-Wilhelm-Gedächtniskirche* (now mainly in ruins), the *Neue Dom* (Protestant Cathedral), the *Siegessäule* and the Great Museums.

There was one factor which must have helped my father to established himself in his profession, the phenomenal growth of Germany's Capital in the years from 1871 to 1914. This was not only visible in the monumental buildings, but also in the three-fold increase of the population during that period. This must have resulted in my father being called for consultations by many new patients, new Berliners coming to the Capital, attracted by the many opportunities promised by this atmosphere of constant expansion.

This was started by the victory in the Franco-Prussian War of 1870-1871 and the resulting large reparations. What was then called *Gründerzeit* (the time of foundation) was outwardly characterised by buildings, not only of the official prestige edifices, but also of the many private luxury houses in the expansion and incorporation of the old nearby villages as suburbs, for example *Dahlem* . This same growth showed itself by the erection of numerous blocks of flats, with their unique inner courtyards. These were for the less wealthy multitudes, needed to work in the many new Ministries of the *Reich,* after its proclamation by the Kaiser in 1871, as well as for the workers in the new industries and those needed to run the *nouveau riche* Capital of a large European country.

Much of this growth was stimulated by the Kaiser who saw in his *Schloss* and his grandiose metropolis an outward sign of his own power and glory. But the real economic progress of Berlin came from Industry, which was attracted by cheap labour and large markets. The names of Siemens, Borsig and AEG, still stand after a century for the electrical industries, for general mechanical engineering and metal industries, which originated in the *Gründerzeit.* Equally important were the chemical industry, the textile factories and the clothing manufacturers drawn to Berlin. Forests and fields gave way to factories, roads and railway lines, as Berlin became the natural center for Germany's steam-engined railways, used for passengers and for goods traffic alike.

A well-known example of this new Berlin landscape, is the *Kurfürstendamm,* in 1880 a mere field path and riding lane, which had by 1910 transformed itself into a prestige boulevard with exclusive luxury shops, street cafés, elegant office buildings and expensive flats. Much older in its renown is the pre-eminent avenue of *Unter den Linden,* with the Brandenburger Tor as its grandiose portal. This avenue dates back to a country road of the 16th century, widened and lengthened by successive monarchs, until it reaches today a width of 60 meters and a length of 1.4 km. By 1889, it received the first electric arc lamp illumination. It extends from the French and British Embassies and the Adlon Hotel, around the Pariser Platz at the Brandenburger Tor on one end, to the *Zeughaus* (armoury) on the other. The center has always been a pedestrian promenade, flanked by lime (*Linden*) trees. In spite of the war, it was fully restored by 1989, after Germany's re-union.

Die konstituierende Sitzung der Kaiser-Wilhelm-Gesellschaft in der Königlichen Akademie der bildenden Künste zu Berlin.

Title 418

The Kaiser's most important action for German Science was to support the foundation of the Society called after him, *The Kaiser-Wilhelm-Gesellschaft*, here seen in their inaugural session at the Berlin Academy of Arts on 11 January 1911. *Courtesy Archives of Max-Planck-Society.*

If buildings, streets and traffic give the first impression of a prosperous, young and growing capital city, though guided by the Kaiser and his ultra-conservative entourage, a deeper look into its political and intellectual life shows that the beginning of the new century contained the seeds for great changes in Berlin during the rest of the 20th century.

Around 1910, Berlin was politically both the capital of Prussia and of the German Reich. It had a Prussian Parliament and in addition the Reichstag, with its deputies elected from the *Reich,* the whole of Germany. Their political future emerged from the parliamentary representation of the working classes, the Social Democrats and later the Communists. By 1918, the end of the first lost World War, these new political parties had gained power when in 1919, the Weimar Republic was proclaimed. My father voted, I clearly remember, for neither the Conservatives, the German National Party, nor for the Left, but for the liberal Centre Party, although it was dominated by the Roman Catholic hierarchy. I can only assume that my mother shared my father's political views.

Similarly, in the field of science, the shape of things to come became apparent. To celebrate the centenary of the Friedrich Wilhelm University, established in Berlin in 1809, the Kaiser decreed in 1911 that a Kaiser Wilhelm Gesellschaft should be created with Adolf von Harnack, the eminent theologian, as its first President and Franz von Mendelssohn as the first Treasurer. It was to carry out scientific research in Institutes, as a single scientist's work was no longer considered adequate to produce new knowledge to assure world leadership for German Industry. The Kaiser's was well advised.

Re-named the Max-Planck-Gesellschaft after World War II now has 30 Institutes in its biological-medical Section; 28 Institutes in the chemical-physical-technical Section; 14 Institutes in the humanistic Section, distributed over the whole of Germany, many of world excellence. These Institutes regained for Germany, after 1945, the high standard in science, which they had lost in 1933 [Title 303]. The Foundation of the Society in the first decade of the 20th century, was undoubtedly the most important event for the future of science in Germany.

As I well remember, my father always subscribed to a number of medical Journals which kept him up-to-date in his special subjects. So for example, during the extremely hot summer of 1911, resulting in a very high death rate of infants, 20 of 100 live births—this must have concerned him deeply. The rapid growth of biochemistry around 1909, the discovery of vitamins, hormones and enzymes, must have interested him greatly and he would have wondered how this new knowledge could benefit his patients.

My Parents during World War I — Title 419

The outbreak of World War I in the Summer of 1914 ended a period of history, not only for my parents, but also for Berlin, for Germany and for the whole World. It was the first war in modern times when the civilian population suffered as much, if not more, than the military forces.

For my parents it meant separation for several years, with my father called up for military service, posted as a doctor to various military hospitals in Brussels and other parts of German-occupied Belgium. They had a personal tragedy, a son born in 1914 survived only for a few days. They tried again, and I was born in August 1916. As my father was called up only in April 1917, I think that he must have assisted, or at least was present, at my birth.

It certainly produced a complete change of life for them. I cannot imagine that my father was content with military discipline and with the need to attend to patients who were completely unknown to him. In his Berlin practice, he was always in close personal contact with those who had consulted him. This fact was recently confirmed to me by a former child-patient, Marianne Feilchenfeldt, née Breslauer, a very well-known photographer in her younger days. Later she became equally distinguished as an international art-dealer in Zurich, and she told me again and again how much my father's visits meant to her when she was a young girl.

My mother had a more difficult time. She had to give up most of her work as a sculptor, as she had to look after a baby, with constant worries how to find and prepare suitable food for it, let alone for herself. Hunger was then an everyday concern in Berlin for all, and the scarcity of meat, vegetables and even potatoes was overruling everything else. In addition, she had an aged mother to care for and help her family, who were apparently not as adapt as she was in coping with the difficult wartime conditions of 1914-1919.

The civilians in the whole of Germany learnt what war really meant in World War I and this was a lesson to be repeated in a far more horrendous form during World War II. There is no doubt that other European women in other belligerent countries also suffered greatly from German aggression, and this extended to many people in Asia as World War II spread. Only American civilians escaped, although their country was involved in both wars and heavy casualties were inflicted on members of their armed services.

I was able to learn much about my parents during these difficult years, from the many letters and cards which they had exchanged frequently. Miraculously these have come down to me, lovingly preserved by my father. To read this correspondence after an interval of 80 years was profoundly moving for me.

My Parents Correspondence 1917-1919 Title 420

My father was called up for military service in April 1917, the fourth year of World War I, and posted as '*Landsturmpflichtiger Arzt*' (Doctor on Militia Service) to War Hospital I, Brussels, in German-occupied Belgium. He remained there for 22 months until after the end of the War, being briefly transferred to other hospitals in Belgium from time to time.

My parents had been married in 1910, and until he was called up, my father had slowly built up a good practice as a medical practitioner and consultant in children's and internal diseases. My parents were living at, and my father was working in, the large and very comfortable flat they rented in the corner house of Landgrafen Strasse 10, Berlin W. 62. He must have been able to have his call-up postponed to 1917, as during August 1916 his son (A.R.M.) was born, and I am certain that as a doctor and loving husband, he would have been present, and perhaps assisted, at my birth.

Physically, the correspondence consists of a 4 cm thick bundle of 30 letters and postcards, the majority in grey-coloured envelopes, marked *Feldpostbrief* without stamps (Military Mail), giving the name of the sender prominently. This bundle must have been preserved with love and care by my father over 22 years, and on his death in 1941 was passed on to me. The most amazing aspect was the fact that three of his letters to my mother had never been opened until I did so 80 years after they were written. This I can only explain by the possibility that my father was on leave in Berlin, and therefore that by then, my parents thought the contents of the letters was out of date.

All correspondence is dated and shows that a regular weekly, occasionally even daily, exchange took place and that the Military Mail took only 2 to 3 days between occupied Brussels and Berlin. Each letter, written of course in German, in a pleasing and polished style, speaks of the deep love and affection that existed between my parents. Never a word of slang or discontent occurred and there is a constant concern for the worries of the other, the lack of consideration by the Military Authorities for my father's posting to smaller hospitals outside Brussels and for the great difficulties of my mother had to find sufficient coal for heating in the winter and obtaining enough food for herself and for feeding the small baby.

A few typical excerpts follow, but here I must record the feelings of a son who has had the opportunity of reading the love-letters of his parents long after their death. It was a deep emotional experience to learn of their constant concern about their baby's survival, with my mother's declining milk due to her poor nutrition, and my father's medical reassurance, all by mail ! Had they then expressed their feelings and emotions by e-mail, what would have been left for me to read after 80 years, unless they had printed-out all their letters.

Comparing life in Brussels and Berlin during World War I with World War II, about 25 years later, is easy. The outstanding difference was the complete absence of air raid danger for the civilian population during the first war and the frequent exposure to bombing, fire and the collapse of buildings during the second, certainly in Berlin and also in London. My father's letter to my mother (Date 170403, the 3 April 1917) reports his nightly sleep of 8 hours and one hour in the afternoon, that he has plenty to eat, receives everything free and can send money to my mother in Berlin. He urges her to eat properly and spend money on food, to buy eggs and preserve them (!), to lay in stores of sausages and other food of a non-perishable nature. (Household refrigerators being very rare, and in a later letter (170901), my father complains that ice was no longer available even in his hospital.)

It is more difficult to picture the working routine of a doctor on duty at the Military Hospital I in Brussels. Battle casualties, which reached many thousands during WWI were not his responsibility, not being a surgeon, and I cannot find any proof in his letters that they were ever channelled to the Hospitals in which he worked. In his letter of April 1917 he mentions that he had anti-typhoid injections, that he treated a case of malaria and that he had to certify two Belgian prisoners of war as being fit for a prison sentence. He had to supervise a small section of severe tuberculosis and diphtheria patients.

In another letter (170622), he mentions a case of severe tuberculosis in a young girl near death whom he has to certify as mortally ill, so that her father, in a German Prisoner of War Camp, might be released to see his daughter before she died. He added "What a grim tragedy—I think permission will be granted".

A number of the letters from Brussels were marked 'Passed by Military Censor', and I can only assume that he was not allowed to write about his professional activities. The number of patients and military casualties in any Belgian Hospital might well be considered security classified, important statistics, which could be valuable to the enemy.(Number of casualties on a given date would show the efficiency of enemy attack).

During his off-duty hours, my father was able to enjoy the culture of Brussels, visit famous churches and the Cathedral, and he went for walks in the Parks, in fact he lived a normal civilian life. He met his medical colleagues in restaurants, purchased food and sent it to Berlin and wrote normal tourist postcards to my mother, reminding her of earlier joint excursions. One of these cards showed the world-famous '*Manneken Pis*', the fountain of a little boy pissing. In those distant war-days, there was no enemy action affecting civilians, either the victors or the defeated.

My mother's letter (170909) to my father in Brussels was of a very personal nature, reporting the wedding of her brother, Franz Bauer, and what she thought of his new wife. She reports her as being "Jewish, nice, clean and of good manners!" and immediately continues with a rumour that General Ludendorff would start peace negotiations in December 1917—"If only this were true!" Obviously, in the fourth year of war, life in Berlin must have become very difficult, and in September all thoughts were concentrated on the coming hard winter.

All my mother's letters contained detailed accounts of the progress and health of the young baby Kurt, born in August 1916. When I was naturalised in England in 1947, I changed my three Christian names, Kurt Otto Adolf, two after my Grandfathers Otto and Adolf. I became Anthony Rowland Michaelis by simple Deed Poll.

So for example in her letter of 170909 she reports to my father that Kurt has had 70 gm breast milk, that he loves grated apple and is starting to eat meat at an age of 1 year and 1 month. In an eight-page letter, four months later (180110), she writes that the baby is weighed every 14 days, gets 750 gm milk, 100 gm cheese, sufficient vegetables, potato and apple purée, buttered white bread and meat twice weekly. (Kurt's age was then 1 year and 3.5 months.) She goes on to say that Kurt is happy and playful, intentionally often left alone, and never cries when he falls down.

My mother must have carried on working as a sculptor, because in her next letter (180411) she tells my father that she has sold a small bronze sculpture for 350 Mark, received from him 600 M and had to take 2500 M from the Bank account to support her mother. She was delighted with the brown winter boots received from Brussels—"I would never get anything like that now in Berlin for any price". But the subject of food is constantly recurring and she mentions a visit to Sumt, the farm of relatives near Berlin, where she obtained a 15-pound ham and no doubt other essentials. She must have gone there by train, as neither my father nor my mother ever owned a car.

My father replied 3 days later (180414) describing his Sunday, starting with a bath and that there were only 3 towels in the house, one for each floor, but that he had extra ones from home. He went to a museum, enjoyed the Flemish paintings by Rubens and van Dyck, true pictures of life at the time—"a pity we could not enjoy them together". He ate with colleagues at the Hussen Restaurant, soup, omelette filled with kidneys, spinach and fried bread, and a sweet. Cost only 3.60 M, only 1 Mark more than in the Hospital.

Title 423

Dr Walter Michaelis, the Author's father in Brussels during World War I in August 1918, while serving in a Military Hospital. Note in his right hand the cigarette of which he smoked an average of 50 a day. *Author's Collection.*

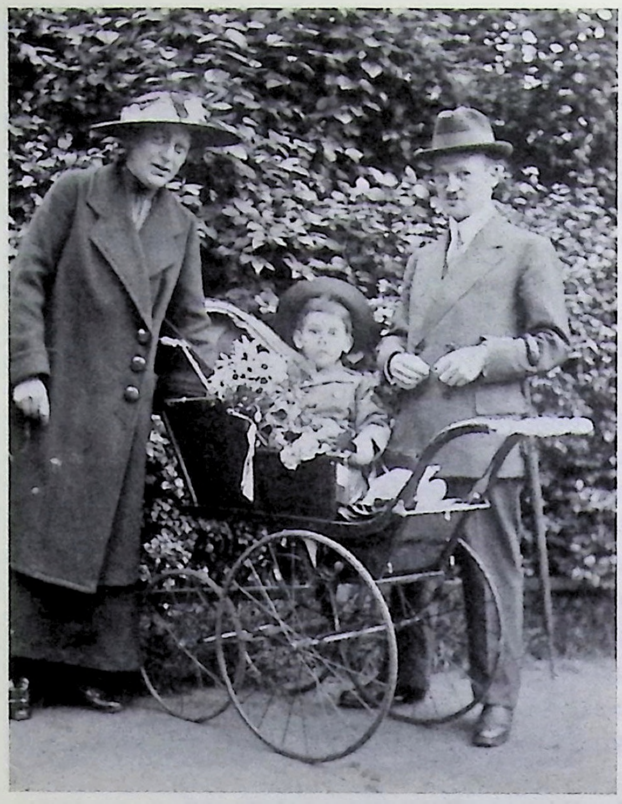
My father wrote in his letter (170530) that a colleague going on leave was taking a parcel containing meat to my mother in Berlin, including a special tongue, salted to keep fresh. It was a birthday present, and it arrived safely to her great delight. The letter was posted from Kriegs Lazarett III, (War Hospital) to which he had been transferred. It was very much smaller, as there was only one other doctor there, and probably situated on the outskirts of Brussels, no location ever being given in his letters. He stayed there for seven months.

From there he was transferred again, this time to a small place of only 2000 inhabitants called Hogstraaten, near Antwerp and close to the Dutch border. He announced this change in an express letter (171201), in which he also told my mother that his replacement had just arrived "a small, miserable, little Jewish medico, only one year after qualifying". This description was no doubt given to indicate the insignificance of his own position in the eyes of the superior medical authorities. The letter finished with a plea for "another small bottle of cognac" to be sent to him. (Probably French war booty available in Berlin, but not in Brussels.)

At the time he gave the reasons for his transfer: No one should be privileged for too long a time by being posted in Brussels, and serving at battalion level for a few months was in the interest of the Military Medical Services and of benefit to the experience of the doctor himself. He was in Hogstraaten for 3 months and spent one further month at the Hospital of the Fortress of Namur, as his postcard (180315) told my mother. "Nothing to write, living with colleagues, conditions good" was the only text on the card.

Back to Brussels and this time at the German Polyclinic, as he wrote in his letter (180414), in which he also described a typical Sunday [see Title 422], no doubt happy to be back in civilised surroundings, although the Polyclinic with only 3 towels does appear somewhat Spartan. The notorious flu epidemic of the period brought a great deal of extra work to my father and my mother wrote (180716) that she hoped it would soon subside. She gave in this and subsequent letters further reports of Kurt's progress, although her letter of 181022 was never opened until I did so in 981108. My father returned to Brussels, as the last document in the series is a telegram from him, dated 190219 in which he gives his new address once more as the Hospital of the Namur Fortress. I do not know when he finally returned to Berlin, as the Armistice had been signed on 11 November 1918.

If I have in the above summary given only the factual details of the war time experiences of a doctor and his wife, I have deliberately omitted the constant expressions of deep love between my parents. These, I think, are too personal and not for general publication.



Title 424

Happy Family together in about 1920 after my father's return to Berlin. *Author's Collection.*

My father's demobilisation from the Army Medical Service must have taken place in 1919 and his return to Berlin would have followed immediately – but I have no documents to prove the date. His home-coming undoubtedly gave him and my mother great joy and satisfaction, they were united again in their love for each other, and my father had the special pleasure of seeing his now 3 year old baby son, Kurt.

But his return home was also full of grave anxiety. Quite apart from re-starting his medical practice as an independent specialist for children's and internal diseases, he had lost for the first time all his savings, invested in war loans. They were completely valueless after the lost war of 1914-1918. The end had come in November 1918, when sailors in Kiel mutinied, revolution broke out in Berlin and Munich, the Kaiser abdicated and fled to Holland, after his family of Hohenzollern had reigned in Brandenburg, Prussia and Germany since 1417.

The year 1919 had started with a General Strike and a Civil War fought between the '*Spartakus Bund*', the Communist hard core, and against them the remnants of the defeated German Army and its right-wing sympathisers. Small scale battles were fought all over Berlin, and I was told that one such engagement occurred at the Lützow Platz, less than one kilometer from our home in the Landgrafen Strasse. The rifle and machine gun fire must have been heard by my parents and by me.

Gradually law and order returned, and later in 1919 the National Assembly in Weimar accepted a democratic-republican Constitution with Ebert as the first German President and a new flag, black, red and gold. For my parents too a civilised life was returning, with my father aquiring new and regaining old patients, my mother resuming her sculpture, and myself growing up, going to school, learning Latin and working hard, following the then still prevalent Prussian tradition of the older teachers in Berlin schools. [Title 4]

Once again, my parents lost all their money during the hyper-inflation which started in 1921 and finished in 1923, when US $ 1 was equivalent to one billion Mark [10 to the power of 9]. Like other professionals, my father had to adopt an immediate use of money earned. While my father treated a patient and was at once paid for his service in cash, my mother waited at the entrance to the house downstairs, received my father's earnings, and immediately bought essential food and other necessities, before a new rate of exchange was announced at noon, and the money had lost its value. As my father had a few foreign patients, who paid cash in dollars, he was very fortunate indeed.

Title 425

Dr Walter Michaelis, the Author's father, telephoning no doubt with one of his patients, a typical scene in our home at 10 Landgrafen Strasse, Berlin, where he and my mother lived until her death in 1929.
Author's Collection.

Once the inflation had ceased in 1923 and a stable currency had been re-established, the life of my parents was one of happiness and professional success. The number of my father's patients grew, not only in number, but also in standing, as his reputation increased. It was particularly the family of Franz von Mendelssohn, with his many children and grandchildren, who not only became patients , but also personal friends for him, and later also for me.

All this came to a sudden and tragic end with the death of my mother . During the winter of 1929, she had caught pneumonia, and in spite of all possible efforts by my father and his colleagues, her decline and death became irrevocable.The last picture I have in my mind is of my mother lying quietly in her bed, next to a large black rubber balloon. My father explained to me that the air in the balloon was to help her breathe. Many years later when I had studied chemistry, I found it particularly tragic that my mother had died in 1929, when only three years later, G. Domagk discovered sulphonamides. In 1935 they were introduced as prontosil, a drug that cured pneumonia.

My father was inconsolable, and only his work and his many friends were able to help him to continue his life. I could contribute very little. He saw at once that this loss also gravely affected me, aged 13 at the time. In those days school ended at lunch time, and as he was completely occupied with his patients, my father wisely decided that a young tutor should be found to spend the afternoons with me, to supervise my home work, to act as an older friend, to go with me to museums, and unforgettably, to take me up the new 100-meter high *Funkturm*, the radio transmitter of Berlin, still standing today.

We were very lucky to find Hans-Joachim Klare, a friend of a son of one my father's colleagues. Klare, soon to be named 'Klärchen' at home, was a graduate student at Berlin University, engaged in writing his dissertation on German classical philology, a discipline introduced by the Brothers Grimm in the middle of the 19th century and still very popular. He was the ideal person for the job. He needed the pocket money, coming from poor parents, and I needed the liberal and scholarly grounding for my life, which he could easily impart.

We became close friends, inspite of the 10 years, difference in our ages. I did not learn any classical philology, as my main interest was already science. When I left for England in October 1933, he gave me a small booklet in which he had written 80 aphorism and quotations. Let one suffice: *Zur Wissenschaft ist der Mensch nicht allein bestimmt. Der Mensch muss Mensch sein. Zur Menschheit ist er bestimmt. Universaltendenz ist dem eigentlichen Gelehrten unentbehrlich* by Novalis (Friedrich von Hardenberg) 1772-1801. As 'interdisciplinarity', and as 'temper', it became a motto for my scientific life.

After I had left for England in October 1933, I was able to visit my father on several occasions in Berlin. Having only a £ 5 per week stipend from an anonymous American friend of my father's, for living and defraying all my University fees, travel to Berlin required a ticket from my father. (I was never able to contact the American friend and thank him.)

In 1936 I had gone to the Madrid University Summer Extension Courses at the former Royal Castle in Santander to learn Spanish, but while I was there, the Spanish Civil War broke out and all non-Spanish students were repatriated. Still being of German nationality, I was transferred by a British destroyer across the Bay of Biscay to the French seaside resort of Juan-les-Pins, and thence by a special train, full of German residents from Spain, to Saarbrücken in Germany. There, a number of student refugees from Nazi Germany and I tried to get away from the official transport and as we were, the first, to leave the Railway Station, we were received by a large group of SA Stormtroopers. Their band struck up a military march, and we were obliged to lead a procession through the town and be honoured as 'Refugees from Communist Spain', as the official stamp in my German passport confirmed. We got away in the end and took a train to Berlin, where we were in time to watch some events of the Olympic Games.

Between 1933 and 1938, I made a yearly visit to Berlin to see my father. On the voyage there, I often travelled with Hilde Himmelweit, whose parents also lived in Berlin, and who was in the same position as myself, a student, at the London School of Economics where she read psychology. Until her early death, we remained close friends and I was glad of her great professional success, finally becoming the Professor of Psychology at the LSE. One of her research projects, for which she received great publicity in the media, was concerned with the effect of horror television on young audiences. When I started my Journal, *Interdisciplinary Science Reviews*, she joined my Editorial Board, and I was always very happy to have her sound comments on manuscripts which had a social science content.

My visits to my father were always a great delight. He had continued to live with his old and excellent cook in our family flat in the Landgrafen Strasse, where life was one of great luxury, compared to my simple student room in London. Being a victim of Nazi prosecution, my father's practice had shrunk, but he was still busy enough to enjoy treating patients. It was during these visits that I got to know him and developed my admiration for his liberal and scholarly character and his generous feeling for others, which I have tried to imitate.

In the 1930s life in Berlin must have become more and more unpleasant for my father, as the Nazi prosecution of all Jews took on ever more virulent forms. Finally in 1938 all Jewish doctors were forbidden to practice medicine, and my father at long last decided to emigrate, following me to England. Money was the simple reason for the delay of his final decision.

Aged 63 by then, he had neither the chance nor the permission to continue medical practice in England. He was not prepared to go through a lengthy course of studying medicine afresh, before being admitted to the essential medical qualifications allowing him to follow his profession. These restrictive conditions were imposed by the British Medical Association, anxious to avoid the competition from foreign doctors, especially if they were as well qualified as my father was.

His only choice was therefore to live in England from his capital as a 'retired gentleman' or depend on charity. No one would have considered him as poor, with a total capital of Reichsmark, RM 71156. As my father kept meticulous records of his finances, which have come down to me, I know that he had to pay one quarter of his total capital, RM 17789, as Emigration Tax before being allowed to leave Germany. Furthermore in November 1938 the Nazi Tax Authorities demanded RM 14600 as a special tax imposed on Jews, as retribution.

The remaining capital, about RM 40000 was entrusted to an accountant for transfer to England. It never reached my father, and the address of accountant was subsequently untraceable. On his arrival in England, the total sum he finally received from Barclays Bank at 168 Fenchurch Street, London's City, was £ 31. 4. 2. In fact my father had lost his savings for the third time in his life in 1938, this time due to capital confiscation by the Nazis for emigrating Jews and the theft of an accountant. He had become a pauper.

In 1938, I was finishing my Ph D thesis in Sheffield [Title 14], and I was living on my £ 5 a week stipend, thus neither able to support my father, nor yet qualified to obtain a job. He was, however, lucky enough to find employment as a resident medical officer at a Refugee Camp for Children in East Anglia, paid for by Jewish Charity. At least he had found a roof and board, and our only hope was that I should obtain my Ph D soon and then find employment that would support us both. Although I did receive my Ph D in January 1940, World War II had started by then, and as 'Enemy Alien', it was impossible for me to be employed. I saw my father for the last time when I visited his Camp during Whitsun 1940. During my weekend there the police collected me for internment. [See Titles 16 and about his tragic death, Title 21]

[In chronological order]

[In chronological order]

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Dehydrogenation Part IV. Catalytic Disproportionation. Together with R.P. Linstead and S.L.S. Thomas. *J. Chem. Soc. London* 1940, p. 1139 *[These were the results of my PhD Thesis]*
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		2	The implacable Law of Life
		3	The wrong Terms of Reference
		4	Technology: Triumphs and Disasters
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		2	Energy 2000
		3	World Health for Tomorrow
		4	Albert Einstein seen by Artists
1979	Vol. 4	1	Interdisciplinary Science Policy
		2	Interdisciplinary Freedom
		3	Space—An Alternative to War
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1980	Vol. 5	1	Interdisciplinary Biotechnology for Nutrition
		2	High Technology Accidents—Unpredictable and Inevitable
		3	The American Question: World War III?
		4	Nuclear Waste—The Battle for Gorleben
1981	Vol. 6	1	The Sea—Servant and Master
		2	Nuclear Prophecy
		3	The Risks of Science
		4	(Lord Ashby: "The State of the Planet")
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		2	The Risks of Technology
		3	The Progress of Agriculture
		4	Science and Politics
1983	Vol. 8	1	Electronic Science Fiction
		2	War and Peace in Space
		3	*Sic itur ad astra*
		4	1984—Warning and Hope
1984	Vol. 9	1	The Sorcerer's Apprentice
		2	More Chemistry—More Food
		3	Interdisciplinary Disaster Research
		4	Past is but Prologue
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		4	(M'Bow: "The 'S' in UNESCO")

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		4	Australia's Bicentennial
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		2	ESA—Partners into Space
		3	Millennium III: Invitation to propose a Monument
		4	The great Challenge
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		2	Anticipating the Future: TA + SF
		3	Cancer—A Declaration of Faith
		4	Global Warming needs planetary Engineering
1990	Vol. 15	1	If Peace breaks out
		2	Drugs—Religion's chemical Surrogates
		3	Brain Drain and Brain Gain
		4	Europe: East and West
1991	Vol. 16	1	The Breakdown of the Car Culture
		2	Environmental Warfare
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1992	Vol. 17	1	Europe's great Challenge
		2	The Earth Summit—Hopes and Fears
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		4	The Golden Honeycomb Sculpture by Michael Ayrton
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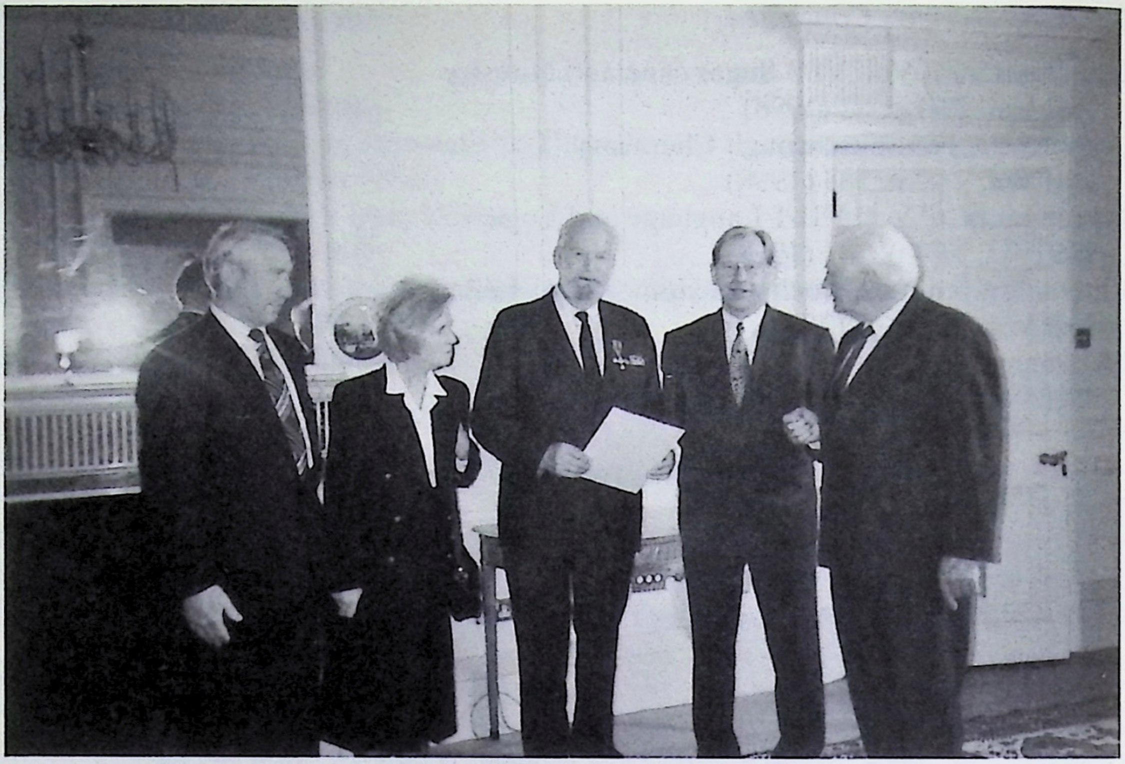


Title 439

The Author (center) at the German Embassy in London, having been presented with the Officer's Cross of the **Order of Merit** of the Federal Republic of **Germany** on 16 April 1993. The insignia were presented on behalf of the Federal President by Herr Dietmar Greineder, Scientific Counsellor at the Embassy, to one who sought to build bridges and increase understanding in Britain for the post-war problems of Germany and German science."

From left to right: Dietmar Greineder, Stefanie Maison, the Author's partner in life, the Author, Dr Hans Mohrhauer and Dr Ulrich Däunert, both previous Scientific Counsellors at the German Embassy and both Sponsors of the Decoration. *Courtesy the German Embassy, London.*

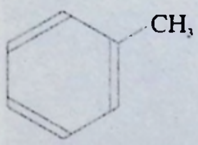
VII. Author's Curriculum Vitae Title 439

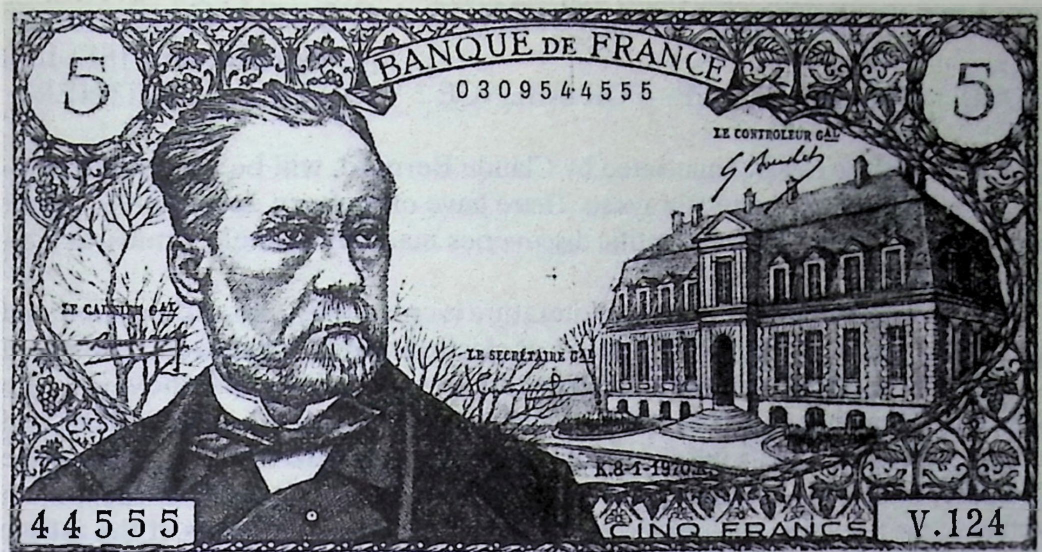
1916	Age	Born 22 August, Berlin
1926	10	Falk Real Gymnasium, Berlin
1933	17	September, left for London
1934	18	Entered Imperial College, London, as Student
1940	24	Interned, first in England then in Canada
1941	25	Returned to England, Ph D, Research and Works chemist
1944	28	Chief Chemist, Director of Research, Milton Antiseptic
1947	31	Head of Research, BIOS, edited *Overall Reports*
1950	34	To Australia to make scientific films, wrote *Research Films*
1955	40	Returned to London, Editor of *Discovery*
1960	44	Wrote *From Semaphore to Satellite* for ITU
1963	47	Science Correspondent *The Daily Telegraph*
1973	57	Founder Editor *Interdisciplinary Science Reviews*
1996	80	Retired to Heidelberg, wrote *The Scientific Temper*
2001	85	*The Scientific Temper* published

The Author's Medal Explained Title 439A

KIND friends had decided to commemorate my 75th birthday with a medal, which I was to design and which was struck by the Paris Mint. The observe is clear, AET is the numismatic abbreviation for AETATIS, AGE.

Explanation of the reverse

SCIENTIA COMMUNICAVI	I have communicated science
THE ASTROLABE	Representing interdisciplinarity of art and science. See Title 71.
NaOCl	Sodium hypochlorite, the antiseptic chemical in Milton. See Title 30.
CIBA	The Swiss Chemical Concern, Title 65.
ITU	International Telecommunication Union, whose centenary book I wrote. Title 69.
	The structural formula of toluene, which we tried to synthesise. Title 26.
ISR	*Interdisciplinary Science Reviews*, Title 259.
IAAS	International Association for the Advancement of Science. Title 354.
RESEARCH FILMS	My first book in 1956, Title 56.
DISCOVERY	The Journal I edited, Title 62.
The Daily Telegraph	Science Correspondent, Title 83.
LONDON	My home from 1933 to 1996.



Title 440

The first Institute for **Scientific Team Work** was the **Institut Pasteur** founded in 1888 by international subscription, and originally designated for research on rabies. Soon expanded to include bacteriology, virology, biochemistry, immunology and molecular biology, it became a center of excellence for research, teaching and the production of vaccines and serums. It also expanded geographically, for example to branches in Algiers, Guyana and other French colonial territories.
This French '5 Franc' banknote, showing Louis Pasteur (1822–1895) on the left and the **Institut Pasteur in Paris** on the right, was in circulation from 1965–1970. *Author's Collection.*

L'ART * C'EST MOI—**LA SCIENCE** * C'EST NOUS

Claude Bernard 1813-1878

(ART * I CREATE ALONE—FOR SCIENCE * WE WORK TOGETHER)

This distinction, so clearly enunciated by Claude Bernard, will be obvious to modern scientists, but this was not always so. There have often been exceptions, with art created by a team, and great scientific discoveries made by a single genius, at least so in the past.

To begin with the obvious: All great Literature is created by one author alone and not by a committee, but unless it is printed, or electronically transmitted, who would ever be able to see, read or enjoy it ? Even more so for Music, as Beethoven's score of his Ninth Symphony may be read by a single person, but needs a Conductor and soloists, with a choir and a full symphony orchestra to create the sound which the Composer wanted the audience to hear. Still further, the modern art of the motion picture or the television play demands a team of creative technicians, if the artistic view of the Producer or Director is to be recorded for later projection to an audience. Only in the visual arts can the artist's lonely work be directly communicated.

Let us take 1663 as the beginning of modern science with the foundation of the Royal Society of London, when about 40 gentlemen met weekly. Typical of these was Robert Boyle FRS, an Irishman, wealthy from the income of his estates in County Cork, and able to use several rooms in his large houses, first in Oxford, then in London, for his air pumps and chemical experiments. Even then Boyle had as his research assistant none other than Robert Hooke FRS, and a few servants to fetch and carry what was too heavy for the two gentlemen.

Real working together in Chemistry started in Justus von Liebig's Giessen Laboratory around 1840 and came to England five years later [see Title 10]. It became more general to work in teams, when a great man had an Institute funded for him, like Pasteur for biological researches on rabies in 1888. The famous Cavendish Laboratory for physics and later nuclear physics in Cambridge, could not flourish until the Cavendish family endowed it in 1871. Henry Cavendish (1731-1810), although a millionaire, never left a penny to science.

The greatest working together for science and medicine for the benefit of mankind so far, through the Scientific Temper, was the total eradication in 1977 of smallpox through the World Health Organisation. WHO is now hoping to finish the Global Polio Eradication, by vaccinating 70 million African children to achieve this. The ISS is another great example of team work.

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Antiscience

Science in London

Science in USA and Flood Danger in Europe

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Synopsis (14)

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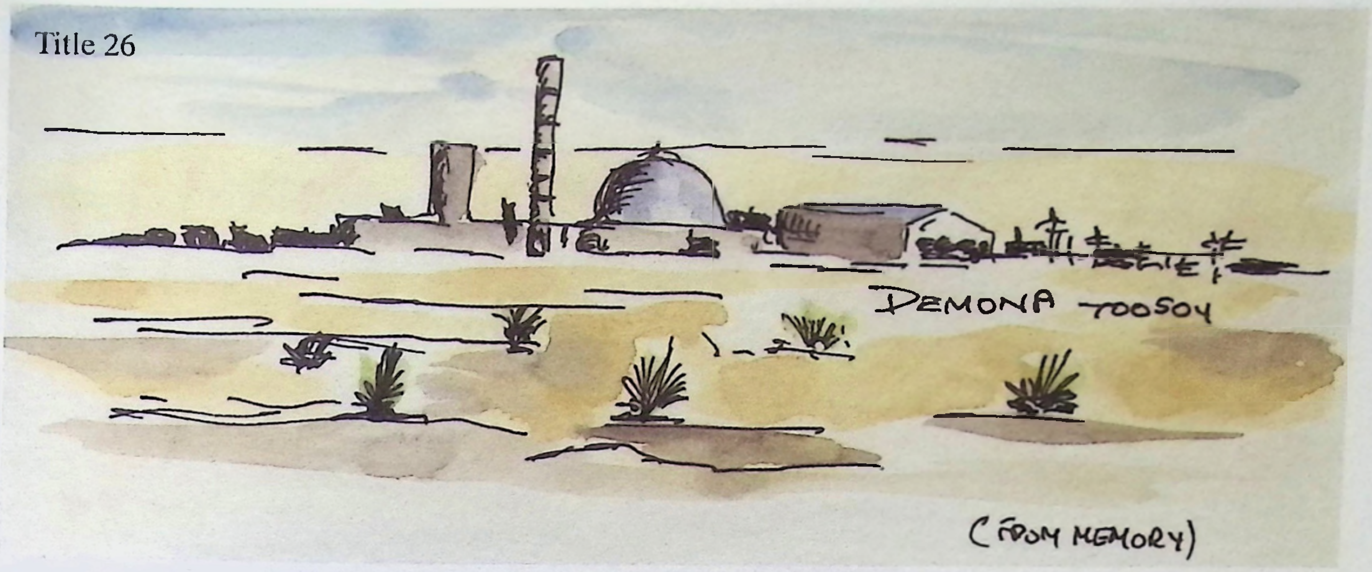
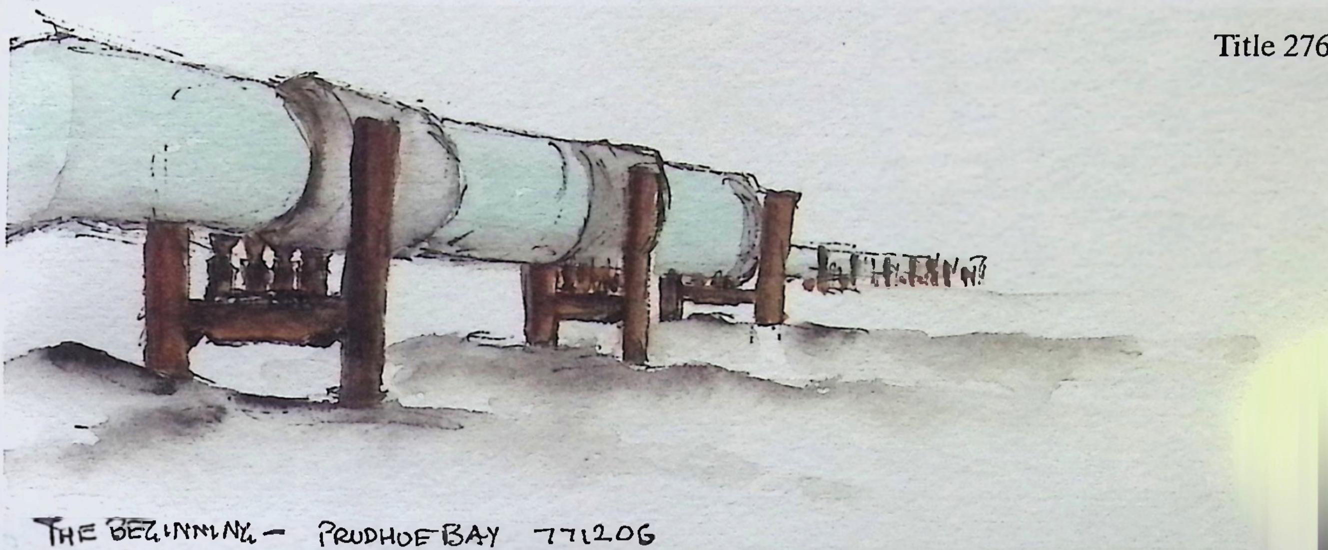
Y

Title 26



Title 276



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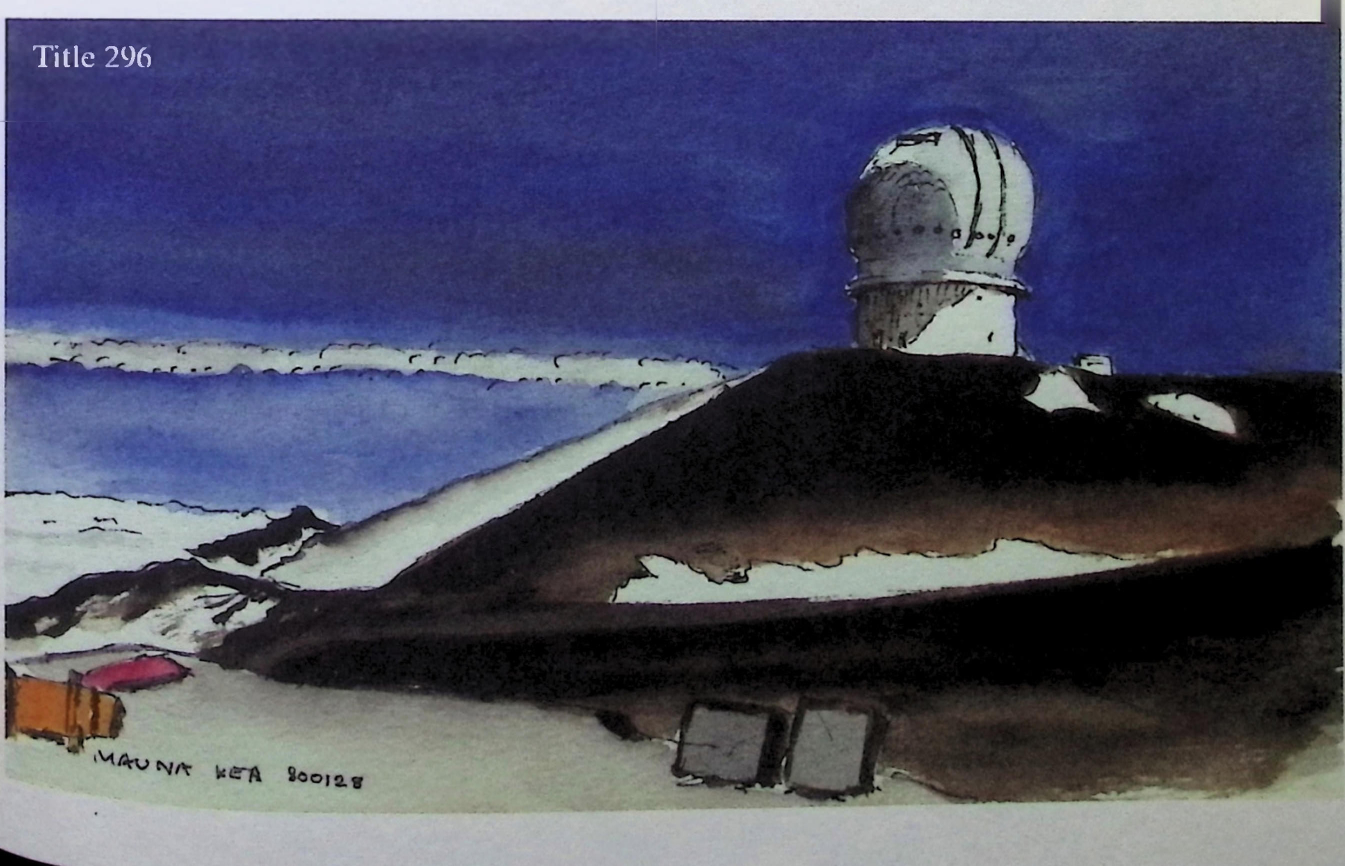
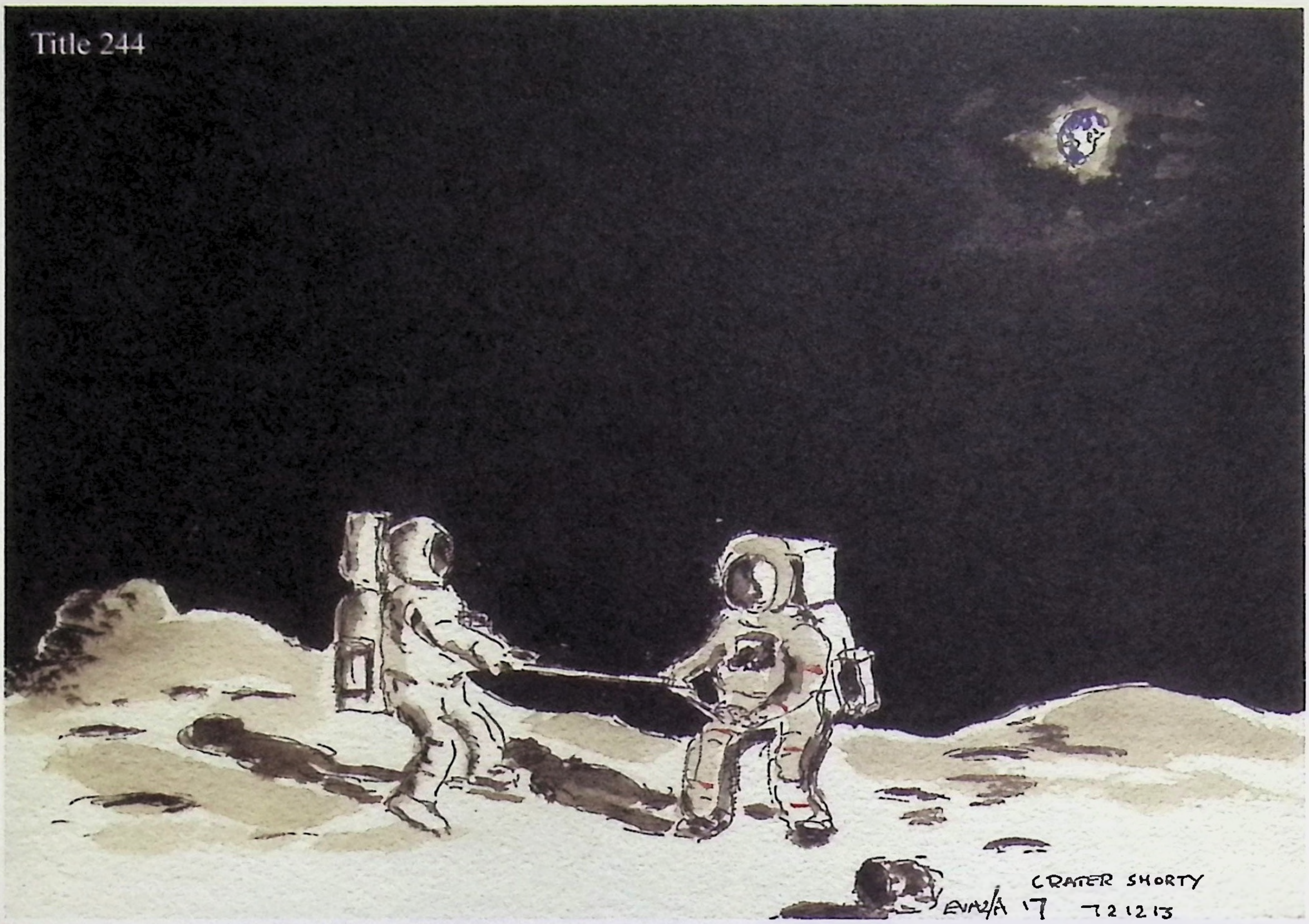




THE AUTHOR'S WATERCOLOURS

Title 244

To return to the Moon – Soon, to sketch. To record EVA 2 Apollo 17, I still had only television.

Title 258

Van de Graaff vertical accelerator at the Weizmann Institute, Israel.

Title 26

Perhaps Dimona, Israel's secret underground atomic bomb factory in the Negev betrays something visible near a public road. (Drawn from memory)

Title 276

Suspended on stilts over the permafrost ground, the hot oil in the Trans-Alaska pipeline starts to flow south from Prudhoe Bay, 70°North.

Title 296

British infrared telescope on Mauna Kea, Hawaii, 4200 m high, in the observatory.

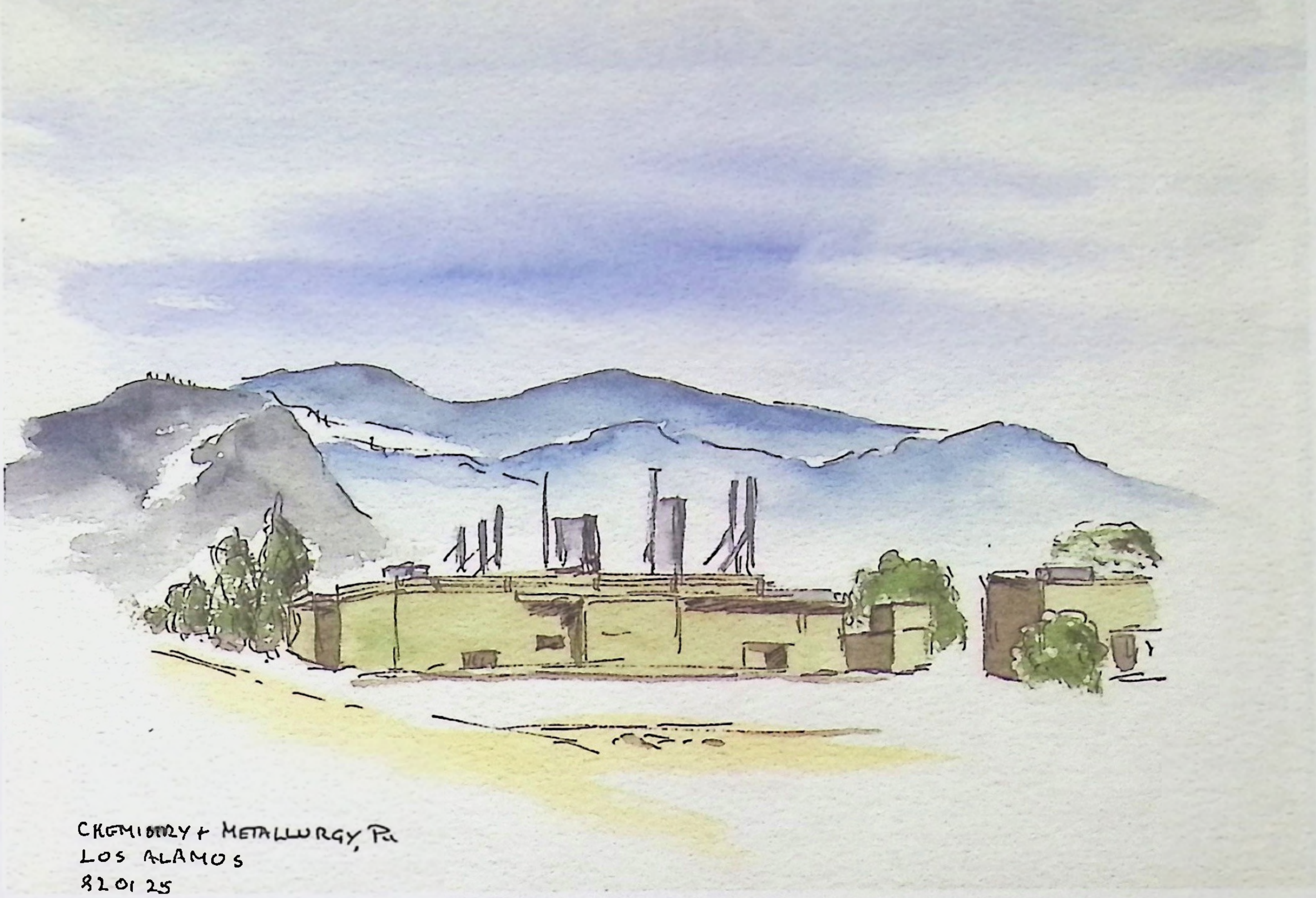
Title 314

At Los Alamos, the chemistry and metallurgy of Plutonium were researched in these huts, which of course I was not allowed to enter.

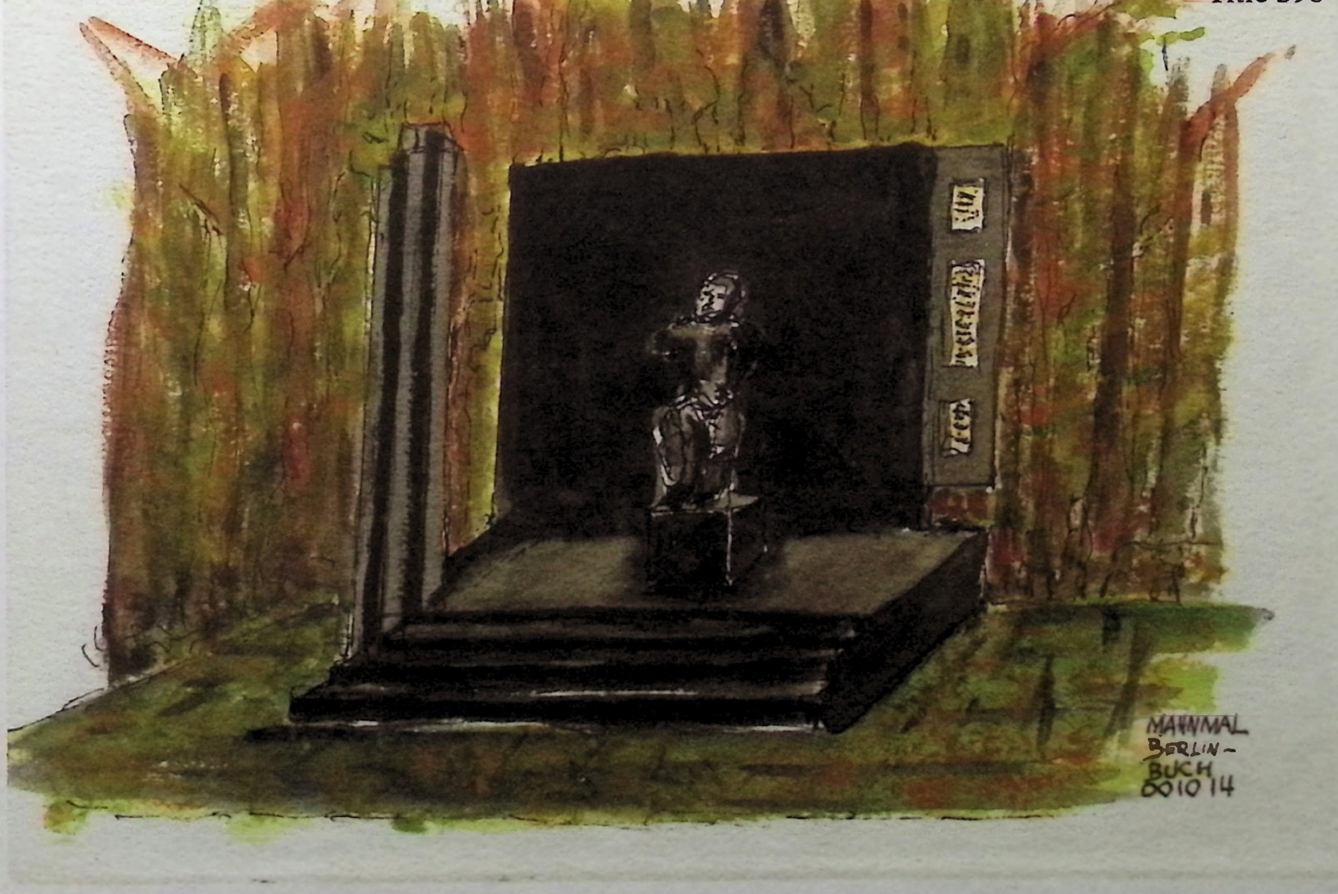
Title 396

At Berlin-Buch in October 2000, a Cenotaph was erected in memory of the children, victims of Nazi medical crimes.

Title 314



Title 396



ISBN 3-8253-1229-1